United States Court of Appeals

for the Second Circuit

EXHIBITS

77-7018

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In the

United States Court of Appeals

For the Second Circuit

J. Gordon Edwards, Ph.D., Thomas H. Jukes, Ph.D.,
Robert H. White-Stevens, Ph.D.,
Plaintiffs-Appellees,

—against—

National Audubon Society, Inc., Robert S. Arbib, Jr., Elvis J. Stahr, Jr.,
Defendants,

The New York Times Company and Roland C. Clement,
Defendants-Appellants.

ON APPEAL FROM THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF NEW YORK

UNITED STATES COURT OF APPEALS
FILED
MAR 8 1977
A. DANIEL FUSARO, CLERK
SECOND CIRCUIT

EXHIBITS
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Plaintiffs Exhibit 1

Pesticide Spokesmen Accused Of 'Lying' on Higher Bird Count

By JOHN DEVLIN

"Segments of the pesticide industry and certain 'scientist-spokesmen,'" are accused in the current issue of American Birds of "lying" by saying that bird life in North America is thriving despite the use of DDT.

The publication is sponsored by the National Audubon Society in collaboration with the United States Fish and Wildlife Service. The delayed current issue is devoted principally to results of the 72d Christmas Bird Count.

The accusation against the pesticide industry and some of its spokesmen is contained in the foreword by Robert S. Arbib Jr., editor.

He wrote that the reason the Christmas Bird Count showed more birds, as cited by pesticide industry spokesmen, was not that there were more birds these days but simply "more birders" who go out on the annual counts and thus increase the size of the totals reported.

Accused Men Named

The persons under attack were not identified in the publication.

However, Mr. Arbib said in an interview that they included Robert H. White-Stevens, formerly with American Cyanamid Company and now in the Bureau of Conservation and Environmental Science, Rutgers University; Thomas H. Jukes, a biochemist at the University of California; Norman E. Borlaug, Nobel Prize winner; Dr. J. Gordon Edwards, a lecturer and professor of entomology at San Jose State College; and Dr. Donald A. Spencer, a retired ecologist and lecturer of the National Agricultural Chemical Association who's now a private consultant and a member of the National Audubon Society.

Not all of the men could be reached for comment but those who could ridiculed the accusations as "emotional," "hysterical," and unfounded, and Dr. Spencer said they were "almost libelous."

"We are well aware," Mr. Arbib wrote, "that segments of the pesticide industry and certain paid 'scientist-spokesmen' are citing Christmas Bird Count totals and other data in American Birds as proving that the bird life of North America is thriving, and that many species are actually increasing despite the widespread and condemned use of DDT and other non-degradable hydro-carbon pesticides.

'Serious Declines' Found

"This, quite obviously, is false and misleading, a distortion of the facts for the most self-serving reasons. The truth is that many species high on the food chain, such as most bird-eating raptors and fisheaters, are suffering serious declines in numbers as a direct result of pesticide contaminations; there is now abundant evidence to prove this."

He said that with the increased coverage of Christmas Bird Counts by the press, it was important for Christmas Count spokesmen to "reiterate what we are seeing is not more birds but more birders.

"Anytime you hear a 'scientist' say the opposite," he continued, "you are in the presence of someone who is being paid to lie, or is parroting something he knows little about."

Servicemen Back Nixon

SAIGON, South Vietnam, Aug. 13 (AP) — The United Service Organization has reported that a straw poll of 1,051 American servicemen who visited its downtown club here from July 16 to 30 gave President Nixon 70 per cent of the votes and Senator George McGovern, 16 per cent. Eleven per cent were undecided and a 3 per cent write-in vote went mostly to Gov. George C. Wallace of Alabama.

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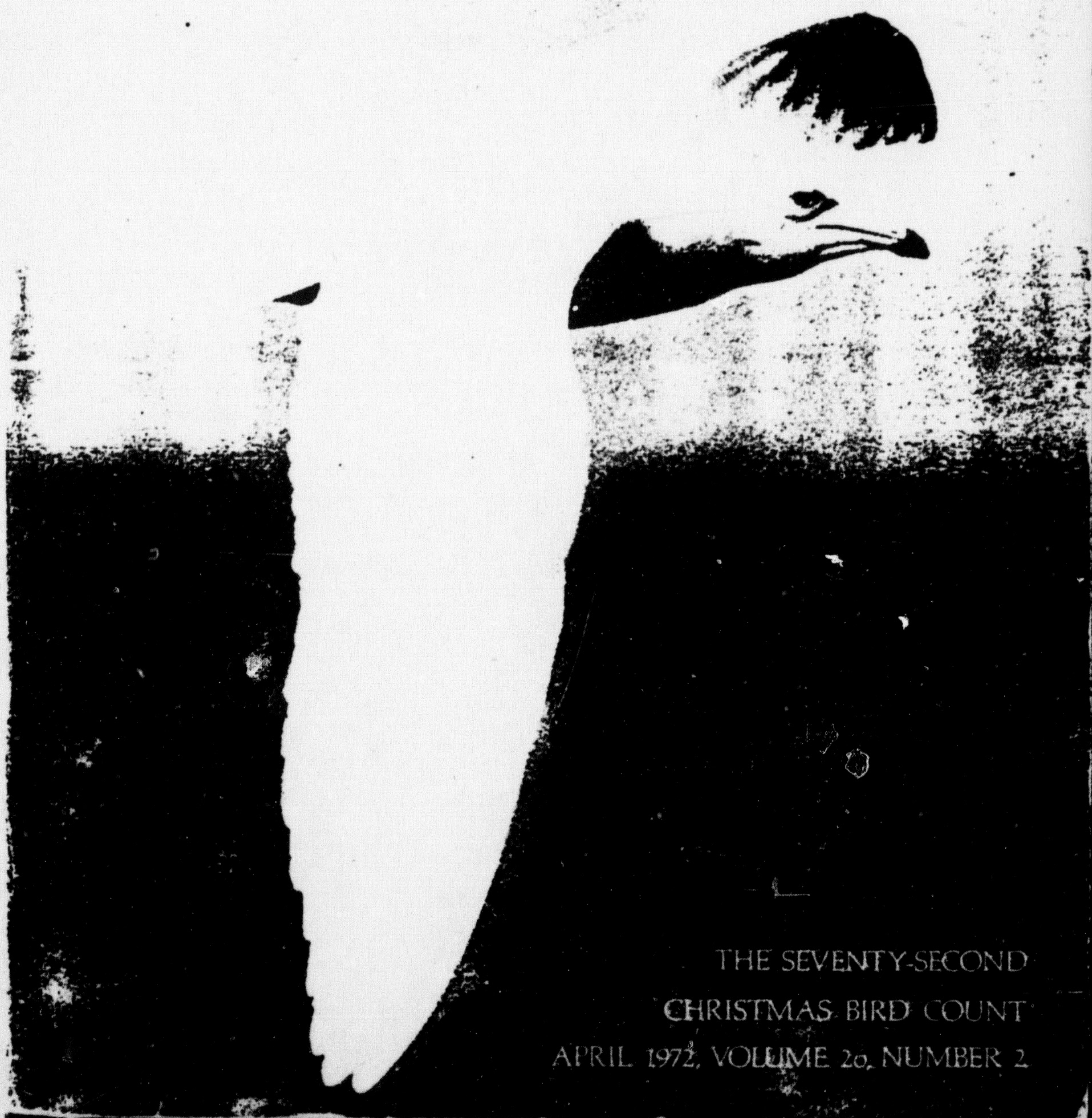

THE SEVENTY-SECOND
CHRISTMAS BIRD COUNT
APRIL 1972, VOLUME 20, NUMBER 2

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AMERICAN BIRDS

incorporating Audubon Field Notes

APRIL 1972, VOLUME 26, NUMBER 2

PUBLISHED BY THE NATIONAL AUDUBON SOCIETY
IN COLLABORATION WITH THE U.S. FISH & WILDLIFE SERVICE

A bimonthly journal devoted to the birds of North America

* * * *

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* * * * *

EDITORIAL ADVISORS	EDITORS
John W. Aldrich	Robert S. Arbib, Jr./*Editor*
Eugene Eisenmann	Chandler S. Robbins/*Technical Editor*
Thomas R. Howell	Allan D. Cruickshank/*Christmas Bird Count*
Robert J. Newman	Willet T. Van Velzen/*Breeding Bird Populations*
Roger Tory Peterson	Ronald A. Ryder/*Winter Bird Populations*
Olin Sewall Pettingill, Jr.	Dorothy Pierpont/*Circulation*
Dale A. Zimmerman	Kathleen Rafferty/*Cartography*

AMERICAN BIRDS is published six times a year. Editorial and business offices are located at 950 Third Avenue, New York, N.Y. 10022. Subscription: $6.00 a year for the U.S.A., $6.25 foreign. Single copies: Christmas Bird Count (April), $3.50 per copy; Fall Migration (February), Winter Season and Winter Bird Population Study (June), Spring Migration (August), Nesting Season (October) and the Breeding Bird Census (December), $1.00 per copy. Checks and money orders should be made payable to AMERICAN BIRDS. Second class postage paid at New York, N.Y. and additional Post Offices. Copyright © 1972 by the National Audubon Society, Inc. *Postmaster: if undeliverable, please notify American Birds on Form 3579 at 950 Third Avenue, New York, N.Y. 10022.*

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Foreword

With the publication of this issue of American Birds, the Seventy-second Christmas Bird Count is now history. New records were again set this year, with 963 counts, and 18,798 participants. With 231 species recorded in Canada, and 583 overall, record totals in this category were also chalked up. This year, just for curiosity's sake (since there is no real meaning to the statistic) a grand total of 64,584,702 individual birds was estimated, of which large numbers were waterfowl, Starlings and blackbirds.

We are well aware that segments of the pesticide industry and certain paid "scientist-spokesmen" are citing Christmas Bird Count totals (and other data in *AMERICAN BIRDS*) as proving that the bird life of North America is thriving, and that many species are actually increasing despite the widespread and condemned use of DDT and other non-degradable hydrocarbon pesticides.

This, quite obviously, is false and misleading, a distortion of the facts for the most self-serving of reasons. The truth is that many species high on the food chain, such as most bird-eating raptors and fish-eaters, are suffering serious declines in numbers as a direct result of pesticide contamination; there is now abundant evidence to prove this. In addition, with the constant diminuition of natural habitat, especially salt- and freshwater marshes, it is self-evident that species frequenting these habitats are less common than formerly.

The apparent increases in numbers of species and individuals on the Christmas Bird Counts have, in most cases, nothing to do with real population dynamics. They are the result of ever-increasing numbers of birders in the field, better access to the Count areas, better knowledge of where to find the birds within each area, and increasing sophistication in identification.

With increased local coverage by the press of Christmas Bird Count activities, it is important than Count spokesmen reiterate the simple and truthful fact that what we are seeing is result of *not more birds, but more birders*. Any time you hear a "scientist" say the opposite, you are in the presence of someone who is being paid to lie, or is parroting something he knows little about.

The devoted reader will find much of topical interest in the pages of CBCs that follow; some of it highlighted in the summary by our Christmas Count Editor, but much of it necessarily omitted for the sake of brevity. Notable incursions of Snowy Owl, Bohemian Waxwing, and all the "winter finches" were evident, especially of redpolls. It was a good year—if not the best ever—for Gyrfalcons, but Hawk Owls were conspicuously scarce. Southern and southwestern counts listed more late-lingerers, especially warblers, than ever, thanks to a wet and warm autumn.

The dearth of coverage from large areas of northern Canada leaves vast gaps in our knowledge; we need observers in such frigid locales as Inuvik, Isachsen, Yellowknife, Churchill, Moosonee, Goose Bay, and other points north. There are, moreover, substantial gaps even in more populated areas. A look at the Index (back cover) will show which states and provinces are now neglected; one good count in the middle of nowhere would be far more informative than a score locked in deadly competition in adjacent and similar habitats, such as found around most metropolitan areas.

With the enormous growth in popularity of the CBC, we are fast reaching the capacity of this publication and its staff to cope. Something, quite soon, has got to give. Perhaps first to go will be counts close to others, but with inadequate coverage. Very little information of value can come from one person covering an area of 47+ square miles in one day. Actually, there should have been imposed long ago a minimum of 10 observers and 5 parties, even if this meant losing some old and faithful participants.

This coming year we will also try to cut the "fat" out of all current counts, including already-published count circle descriptions, irrelevant weather notes, and unnecessary "verification" notes. The new instructions (page 546) will give details. Perhaps contrarily, next year we are going to open, with some trepidation, the publication to CBCs from the West Indies and Central America (Mexico through Panama) reflecting our greater interest in bird study and conservation in these regions. This decision is against the better judgment of our retiring Editor, and is made with the strict proviso that accepted species names only be used. Accepted names are those used by Eisenmann, E., *The species of Middle American birds*, Trans. Linn.

Soc. N.Y., VII, 1955. Friedmann, H., L. Griscom and R. T. Moore. *Distributional Check-list of the Birds of Mexico.* Pac. Coast Avifauna 33., Cooper Ornith. Soc., Berkeley, Cal., 1957, or handbooks generally conforming to these works. The recent Mexican Field Guide by Irby Davis (Texas University Press, 1972) while of considerable merit, may not be used *for nomenclature*, since it differs radically from all others.

This coming year we would like one added bit of information that may be helpful in explaining winter incursions. Northern and mountain areas will be asked to note the condition of cone and berry crops: poor, fair, good, excellent (see instructions).

We do not believe that it is yet clear to all compilers that the very same count forms they return are used by typesetters to set this issue in type. Because these forms come in to us in hundreds of different personal writing and printing styles—some tiny, some neat, some sloppy, and some almost illegible—because it is a complicated form, with pages to turn, it is considered "difficult" copy, and takes longer (and costs more) than typewritten manuscript. Compilers who do not follow instructions to the letter add to our editing time and our typesetting costs. Faint pencil, blurred felt-tip pens, unacceptable abbreviations (i.e. R.-sh. Hawk) out-of-order species all slow the work. But if some of the lengthiest counts come in letter perfect, so can all.

Once again, a note on the participation fee. After annual explanations for years, we still hear the occasional "Why should I have to pay for my day's birding?" The reason is simple. Without the fee, there would be no funds to print the packet of forms each compiler gets, to mail them, to edit the returned counts, to publish the CBC issue, or to mail it. No fee—no Christmas Bird Count. Even with the $18,798 received in participation fees this year, the Christmas Bird Count still represents a deficit operation for the National Audubon Society, and an actual subsidy to every participant. Some day, perhaps, an end to the fee will be possible; the quickest way would be for every subscriber to bring in a new subscriber!

One final milestone has been reached with this issue. Allan D. Cruickshank, the eternal youth, claims that he has reached the age of 65 and will retire at year's end. This is obviously a preposterous lie, since Allan is still chasing across marshes and mudflats with all the competitive zest he exhibited only yesterday as a 20-year old. Over the years he has contributed by example and exhortation, more than anyone to the mammoth growth of this annual spectacular, and to say that he will be replaced by a team of regional Count editors is inaccurate in one sense; he cannot be replaced; it will take a team to do his work. He himself will be a member of that team as long as he desires, which should take us well into the next century. Meanwhile, in retirement, we wish him good birding, sharp pencils, and Cocoa on top once more!

Other members of the editorial staff for this issue include our Technical Editor, Chandler S. Robbins, our arbiter of high counts, Burt L. Monroe, Jr., a new compiler of Canadian high counts, Ross Anderson, of Nova Scotia, and our good right hand, whose many services were noted last year, Lois Heilbrun.

—Robert S. Arbib, Jr.

Imm. Bald Eagle, Oradell Reservoir, N.J. Seen on Hackensack-Ridgewood CBC, Dec. 18, 1971. Photo/Stephen E. Munz.

THE SEVE

Edited by Allan

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NATIONAL AUDUBON SOCIETY

950 THIRD AVENUE, NEW YORK, N.Y. 10022 (212) 832-3200 Cable: NATAUDUBON

August 14, 1972

Editor
New York Times
229 West 43d St.
New York, New York

Dear Sir:

Jack Devlin's punchy piece on the Audubon Christmas Bird Count summary from the April issue of AMERICAN BIRDS unfortunately leaves out the most important qualifications we attach to these counts.

It is not simply that more birds are reported because there are more birders, but that we have more birders who are also better birders, who have "better access to the Count areas, better knowledge of where to find the birds within each area, and increasing sophistication in identification."

This is why our counts, though they have many uses, are not a reliable clue to population changes from decade to decade. There is no way around this problem in interpretation because we do not know exactly how much the birder himself has been improved as an observer over the years.

Nor do we like to call people liars, but those who have most consistently misused our data--Robert H. White-Stevens of Rutgers University, Thomas H. Jukes of the University of California, J. Gordon Edwards of San Jose State College, Donald A. Spencer of the National Agricultural Chemicals Association, and more recently Nobel laureate Norman E. Borlaug--certainly have had time to learn from our patient explanations of their misinterpretations of our data over the several years of the DDT controversy.

Sincerely,

(signed for Arbib by RCC after telep
Arbib in N.Dak. at AOU)

Robert S. A

PLAINTIFF'S
EXHIBIT
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Plaintiffs
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PESTICIDE INFLUENCE ON BIRD POPULATION

Philip H. Marvin

Spring will be strangely silent claims a recent monthly book selection. The songs of birds will be stilled. No longer will we hear the spring peepers. The new growing season will be ushered in with tomb-like quietness. Pesticide chemicals, according to the authoress of this book, are destroying such harbingers of spring along with other wildlife. Robins, she intimates, are on their way to extinction. Increased chemical control of insects, weeds and other pests has produced in large areas springs now unheralded by the return of birds and where the early mornings are strangely silent where once they were filled with the beauty of song birds is the theme of a chapter.

Facts show this to be a misrepresentation. Rather than decreasing, bird populations have increased tremendously during the past decade of greatly increased usage of modern insect and weed control chemicals. The book does give an emotionally convincing story. Cold figures prove the conclusions to be in great error.

Data accumulated by bird watchers and published by the National Audubon Society with the United States Fish and Wildlife Service refute such conclusions. The data show a population explosion among birds while the insecticides and herbicides have reached their greatest use in protecting our crops, foods, forests, city trees, yards and homes.

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Pesticide Influence on Bird Populations -- Philip H. Marvin

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Bird watchers, the author of this paper being one of them, take an annual census of birds in North America. The counting started in 1899 thru the initiative of the famous naturalist, Dr. Frank M. Chapman. Nearly 9,000 ornithologists now take the annual census. They go in groups or singly to find how many birds of each species they can observe. The counts are made during Christmas week, and are popularly known as the Christmas Bird Counts. Stringent rules make the counts reliable for comparison over the years.

"The Christmas Bird Counts serve as a good inventory of our December birdlife. No other month of the year receives such intense wide-spread coverage.", wrote the world famous ornithologist, Allen D. Cruickshank (Audubon Field Notes 11:(2), 1951). He also described this census as, "The Christmas Bird Count is probably the longest organized cooperative bird watching activity in the entire world." (Audubon Field Notes 12:(2), 1956). These annual records give the most accurate picture of our bird populations.

Data from the Christmas Bird Counts are published in Audubon Field Notes, a periodical sponsored by the National Audubon Society and the U.S. Fish and Wildlife Service. The figures in the table below, taken from this magazine, show a steady growth in bird populations according to the Christmas Bird Counts:

Year	Total birds recorded	Number of observers
1940	2,000,000	2,200
45	3,136,000	2,300
50	6,469,000	4,875
51	7,507,000	5,151
52	12,158,000	-----
53	(not summarized in Audubon Field Notes)	
54	17,648,000	7,612
55	24,883,000	6,331
56	18,911,000	6,543
57	35,146,000	5,927
58	33,891,000	7,438
59	32,710,000	8,000
60	52,524,000	8,928

Many reasons can be given as causing this bird population explosion. It will suffice here to point out that the meteoric rise in the two decades accompanies the great increase usage of pest control chemicals.

Individual bird species, closely associated with the use of pesticides, show corresponding rises in populations according to the data in the Audubon Field Notes. Robins, according to the quiet spring book, have been reduced to the verge of extinction. The reliable data show robin populations increasing almost ten-fold in the last dozen years.

Years	Average annual robin counts
1949-52	41,214
1953-56	86,386
1957-60	367,733

This rise in the number of robins accompanied the increase spraying to protect city trees from attack by insects. Robin populations actually are increasing at a faster rate than starling, as shown by the following:

Years	Average annual starling count
1949-52	717,477
1953-56	1,561,710
1957-60	5,799,820

Although the rate of increase is greater for robins, starlings have increased much more in numbers. Both species feed on the grubs, earthworms, beetles and other food in the lawns under the trees sprayed for control of Dutch elm disease, canker worms, elm leaf beetle and other pests.

Many other home yard birds show rises in populations during this period when chemicals have been relied upon increasingly more for insect and weed control, as shown by the following figures, also taken from the Christmas Bird Counts:

	Average Annual Counts			
Years	Mourning Dove	Flicker	Mockingbird	Cardinal
1949-52	13,131	4,278	4,430	19,576
1953-56	32,752	5,980	9,802	31,375
1957-60	59,886	7,500	14,027	43,191

(Note: figures for 1953 not included for the first three birds, as such were not summarized in Audubon Field Notes.)

An explanation may be in order as to why these particular yard birds were selected. The mourning dove lives in mid-western cities, making loosely built nests which direct spray streams could knock apart. Yet this species has increased over 4-fold. The flicker, described as the best known woodpecker to urban people, continues to increase despite the spraying of its environment. The song of the mockingbird, so well publicized by verse, is far from silent, despite imported fireant control programs in the South. The flashy cardinal, a seed eater and nesting in shrubs, shows an increase, but less so than other species directly associated with the sprayed trees.

Pesticide Influence on Bird Populations -- Philip M. Marvin

Many Species of birds associated with agriculture also show tremendous rises in populations in the past 12 years, according to the Audubon Field Notes. Crows have doubled in numbers, from 107,441 to 227,302; despite their close associations to cutworms and other field insects which farmers so frequently need to control with chemicals to stay in the business of producing our food and clothing crops. The killdeer, a bird of chemically treated meadows and other open ground, increased from 6,523 in 1949 to 18,191 in 1959. The redwing blackbird, jumping from 1,399,466 to a whopping 20,049,213, probably is our most common bird. Its gigantic increase coincided with the increase spraying of its marsh habitats for mosquito control.

While the total bird populations have been increasing, local bird numbers may vary for any of a number of reasons. Man may be responsible for some, natural conditions for others. In either case, the changes more likely are shifts in populations. A tree falling in a forest starts a new ecological succession in a localized area. Birds and other animals living in the tree move to new quarters. Sunlight, now penetrating to the forest floor, gives grasses and shrubs the conditions they need for growth. New species of birds, associated with such plants, move in. The same process occurs when fires, started by lightning, wipe out the existing vegetation over large areas and new plants then establish themselves.

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Pesticide Influence on Bird Populations -- Philip M. Marvin

The authoress of the silent vernal season book claims that the balance of nature is a fluid, ever shifting condition, in a constant state of adjustment. Man, she points out, is a part of this balance. This is a very agreeable statement. Man-made objects may kill many birds. Over 20,000 birds were reported killed by T V towers in the autumn of 1960 (Audubon Field Notes 15:(1):78) Yet, by putting up bird houses, by maintaining feeding stations and by keeping bird baths supplied with water, we perpetuate many birds which the rigors of nature would otherwise eliminate.

No one knows what the future population counts of birds will be. The great rise in their numbers opens them up to epidemics of cummunicable diseases. Since there are so many more birds present, people will be finding the dying and dead ones much more readily, whether the birds die from diseases, accidents or other causes. At times pesticides will be blamed, with justification in some instances. More frequently, pesticides will be incriminated by association without just reason. This has happened in the past. Bluebirds have been on the decline since 1957. The imported fireant control program in the South was said to be the cause, since so many bluebirds migrated to such areas for the winter. However, as recently reported in Audubon Field Notes (_________, 1962), decreases showed up in the bluebird populations which never visited the areas of imported fireant eradication. Probably severe winter weather has been responsible, as Forbush noted for bluebirds in the last half of the previous century (*Birds of Massachusetts and Other New England States*, Vol. 3, p. 419).

When bird populations drop or shift, the temptation to accuse insect and weed control activities will be great. Frequently it is the easy way to solve a problem, even if the solution is erroneous. All factors need to be considered by well trained persons to approach the truth. Reliable scientists use as much data and facts as possible in drawing conclusions. Many others rely on single observations and even on incorrect conclusions of others. Emotional appeal sways the masses, at times to acts of foolishness. It requires strong character to ascertain the facts in order to see reality accurately.

The booming insect and weed killing chemical business has been well matched by the soaring populations of birds, despite claims to the contrary. Misuse of pesticides occurs occasionally. Misuse of ideas, as noted in this article, has been more flagrent. Both are to be deplored. The poisoned pen can be the more detrimental to man when it initiates unwise action. The public needs facts, not misconceptions, to act with sound judgement.

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unchanged since 1899—was finally transformed by you
Roger Tory Peterson in 1935. The name was changed in 19

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The evolution of a magazine

by ROGER TORY PETERSON

IT IS NOT GENERALLY KNOWN that way back in 1887 and 1888 there was a monthly publication named *The Audubon Magazine.* Devoted to songbird protection, it was "published in the interests of the [Audubon] Society" by the Forest and Stream Publishing Company of New York. The annual subscription was fifty cents, and a single copy cost only six cents.

Dressed in a gray cover with a steel engraving of John James Audubon, it ran such articles as "How I Learned to Love and Not to Kill," "A Plea for Our Birds," "Bluebird Dick," "Wrens in a Coffee Pot," and "Reintroduction of Feather Millinery." And a fantasy series for children entitled "Charley's Wonderful Journeys." The passenger pigeon and the Carolina parakeet were not yet extinct—not by some years. But the magazine and the society to whom it was dedicated soon would be; America, unaware that it was rapidly losing its wild heritage, was not yet ready.

With the urgent revival of the Audubon movement under a different aegis eight years later, it became evident that an official organ was needed if the fledgling conglomerate of local societies was to survive. The magazine that filled the niche was *Bird-Lore*, financed and launched in February 1899 by Frank M. Chapman of the American Museum of Natural History, who was to become the dean of American ornithologists.

"A Bird in the Bush is Worth Two in the Hand" was the motto that appeared on the *Bird-Lore* masthead. The first nine bimonthly issues were, with Mrs. Chapman's assistance, sent out from their home at Englewood, New Jersey; but the nights were scarcely long enough for the labor involved. In August 1900 the operation was moved to Harrisburg, Pennsylvania, where the MacMillan Company, the publisher, and later J. Horace McFarland Company, the printer, took on the task of mailing and distribution. Price in those days? One dollar a year, twenty cents per copy.

In his "prospectus" setting forth the aims of the magazine, Chapman had stated that every prominent writer on birds promised to contribute to *Bird-Lore*. Before the second year was up he made good the promises with articles by William Dutcher, A. K. Fisher, Ernest Thompson Seton, William Beebe, Robert Ridgway, Mabel Osgood Wright, Florence A. Merriam, J. A. Allen, William Brewster, Witmer Stone, Bradford Torrey, Otto Widmann, and many others. The very first article was "In Warbler Time," by the "sage of Slab Sides," John Burroughs. Three years later, Ernest Thompson Seton, writing on the recognition marks of birds, presented the first overhead flight patterns of the birds of prey.

The annual Christmas bird count was born the second year. In *Bird-Lore* for December 1900, Frank Chapman wrote: "It is not many years ago that sportsmen were accustomed to meet on Christmas Day, 'choose sides,' and then . . . hie themselves to the fields and woods on the cheerful mission of killing practically everything in fur or feathers that crossed their path . . . Now *Bird-Lore* proposes a new kind of Christmas side hunt in the form of a Christmas bird census, and we hope that all our readers who have the opportunity will aid in making it a success by spending a portion of Christmas Day with the birds and sending a report of their 'hunt' to *Bird-Lore* before they retire that night."

A total of 27 people from 25 localities took part in the first Christmas count in 1900. In succeeding years the count became so popular that by 1971 the number of participants grew from that small nucleus to 18,798, representing 963 areas. That report (like the preceding sixteen reports it was edited by Allan Cruickshank) is exactly one inch thick. Analyzed intelligently, these counts, as well as the seasonal reports of field observations in various parts of the country that have been published since 1918 under the title of "The Season," tell us much about the population trends of birds. From the conservationist's point of view, shifts in bird populations are excellent indicators of the environment—a sort of "ecological litmus paper."

"The Season," the "Breeding-Bird Census" (started in 1937), and the Christmas count, all of which were originally included among the pages of the magazine, were separated in 1939 to be published independently as *Audubon Field Notes* (now *American Birds* under the editorship of Robert Arbib).

Perhaps the most extraordinary single feature of the

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Roger Tory Peterson—Audubon Medalist, 1971

"Gifted artist, author, lecturer, interpreter of birds to the world, and a clear, strong voice for Conservation.

He has opened the eyes of millions to the beauty of Nature's design, aroused, recruited, and led them in defense of Nature."

With this citation, National Audubon Society President Elvis J. Stahr presented the Audubon Medal to Roger Tory Peterson, who probably has interested more people in birds—and in the environment—than any other living man. The ceremony took place during the society's annual dinner in New York City on November 17th.

Dr. Peterson is the seventeenth recipient of the Audubon Medal, an award that was established 27 years ago to extend recognition to individuals for outstanding accomplishments in conservation.

The medal was last presented in 1969, to Horace M. Albright of Los Angeles, one of the important builders of the National Park System. Other recipients have included Rachel Carson and former Secretary of the Interior Stewart L. Udall.

Since Dr. Peterson's books are available around the world—there are now more than six million in print in fourteen languages—his name is probably known to more persons than that of any previous Audubon Medal winner, with the exception of the late Walt Disney.

The Peterson bird guides, and the general field guide series of which he is editor, are standard reference works for identification of both animal and plant life. It was Dr. Peterson, in fact, who formulated the field identification system most commonly used today. It first appeared in his pioneering *Field Guide to the Birds* in 1934.

Dr. Peterson's influence as a spokesman on conservation issues has been felt around the world—in the United States and South America, in Africa, Great Britain, and Europe, and all the way to Antarctica and even the Indian Ocean. His bird paintings and illustrations are widely known and admired, and his extraordinary films of wildlife in remote areas reveal his profound knowledge of and appreciation for all living things.

Roger Tory Peterson's association with the National Audubon Society is long standing. For more than 35 years he has served as art director, consultant, or board member, as well as a contributing editor of *Audubon*. He has been a leading spirit in the broadening, over the years, of the scope of the society's interests in environmental preservation.

Dr. Peterson also serves on the board of the World Wildlife Fund and as art director for the National Wildlife Federation.

Among his other honors are the John Burroughs Medal for nature writing, the Gold Medal of the New York Zoological Society, and the Frances K. Hutchinson Medal of the Garden Club of America. He is a fellow of the American Association for the Advancement of Science and the American Ornithologists' Union, a member and past president of the Wilson Ornithological Society, vice-president of the Society of Wildlife Artists (England), and an honorary member of the British Ornithologists' Union. ■

Audubon's five new directors

Five new directors of the National Audubon Society were among the twelve elected during the annual members' meeting November 17th to serve three-year terms. They are:

Richard M. Cutler of Beverly Farms, Massachusetts, senior vice-president, treasurer, secretary, and director of the Putnam Management Company of Boston, as well as adviser to eight investment funds. He is a director of the Massachusetts Audubon Society and also serves as chairman of the board of the Austen Riggs Center of Stockbridge and a trustee of the Brookwood School in Manchester.

Hugh Downs of Carefree, Arizona, noted television personality and host of NBC's "Today" show for nine years. He left that show last fall to devote his time to his own projects—including special shows on the environment. This subject has long been one of Mr. Downs' major concerns, and in the past several years he has made documentaries on "The American Wilderness," "The Everglades," "The Great Barrier Reef," "Survival on the Prairie," and "The First Americans."

C. A. Porter Hopkins of Glyndon, Maryland, a member of the Maryland House of Delegates who was elected minority leader last year. A farmer and former editor of the *Maryland Conservationist*, Mr. Hopkins is a longtime member of the Audubon Society and also has been active with the Chesapeake Bay Foundation, Ducks Unlimited, and the Izaak Walton League. He was named soil conservationist of the year in 1968 by the Maryland Wildlife Federation, headed the Citizens Committee for the Preservation of Assateague Island in 1965, and has been a member of the Baltimore County Board of Recreation and Parks since 1963.

Jeffrey R. Short Jr. of Chicago, president of the J. R. Short Milling Company and a former State Department attaché stationed in Ankara, Turkey. Mr. Short is a trustee of the Chicago Academy of Sciences and the Chicago Zoological Society, a director of the Nature Conservancy of Illinois, former honorary vice-president of the American Forestry Association, and president of the Chicago Open Lands Project.

Mrs. V. Crane (Vim) Wright of Denver, Colorado, president of the Denver Audubon Society and active in conservation causes and associated public education projects. She is presently involved in the opposition to the federal oil shale leasing project; she leads the Denver group in seeking reform of both state and federal predator control programs, and recently was named to serve on a state predator control policy study committee established by the Colorado governor. Mrs. Wright is organizer and coordinator of Denver Audubon's controversial TV program, "Environmental Hotline."

Board members elected to serve again are: George P. Bent II of Greenwich, Connecticut, civic leader and former insurance executive; Lawrence W. Lowman of Stamford, Connecticut, former radio and television executive; Peter Manigault of Charleston, South Carolina, president and publisher of the *News and Courier;* Dudley H. Mills of Glen Head, New York, retired banker; Philip W. Pillsbury of Minneapolis, Minnesota, retired board chairman and former president of the Pillsbury Company; Gene W. Setzer of Nyack, New York, an executive with the Rockefeller Brothers Fund; and Alan T. Wenzell of New York City, a vice-president with the brokerage firm of Paine, Webber, Jackson, and Curtis. ■

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1972

AIR MAIL

Jukes

SPACE SCIENCES LABORATORY
University of California
Berkeley, California 94720

To
Mr. John C. Devlin
News Room
New York Times
229 West 43rd Street
New YOrk, N. Y. 10036

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Trustees for Conservation

. . . To secure the support of the people and the government in preservation of national parks and monuments, wildlife, and wilderness areas.

251 KEARNY STREET • SAN FRANCISCO, CALIF. 94108
235 MASSACHUSETTS AVE., N.E., WASHINGTON, D.C. 20002

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Charles G. Woodbury

August 7, 1972

Mr. John C. Devlin
New York Times, News Room
229 West 43rd Street
New York, N. Y. 10036

Dear Mr. Devlin:

Thank you for your telephone call.

Enclosed are the items from the Hawk Mountain Sanctuary Association newsletter, recording and commenting on the increase in the osprey count.

Sincerely yours,

Thomas H. Jukes

Thomas H. Jukes

PLEASE REPLY TO:
1414 South Tenth St.,
Richmond, Calif. 94804

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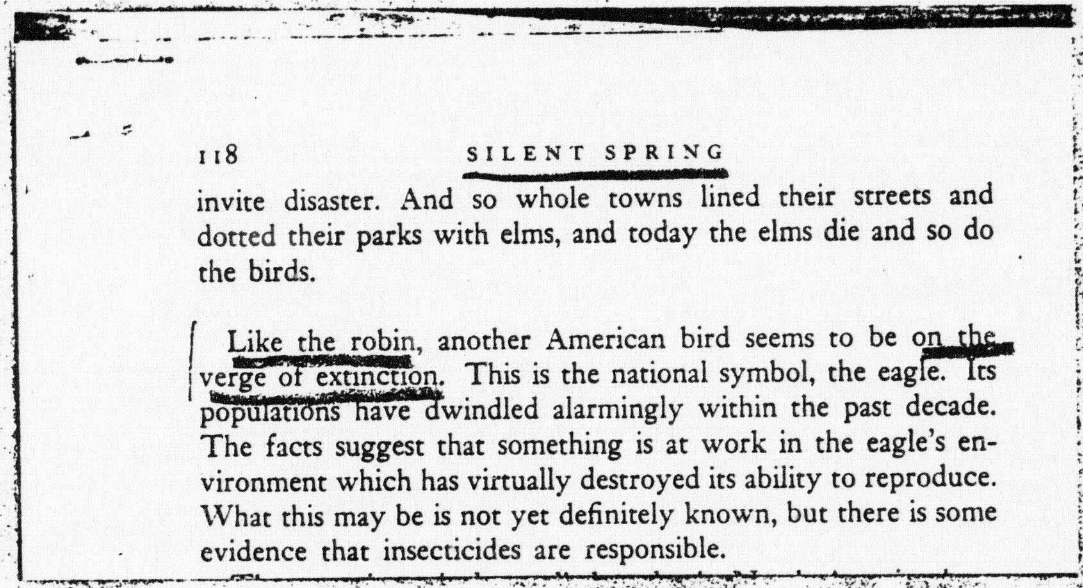

invite disaster. And so whole towns lined their streets and dotted their parks with elms, and today the elms die and so do the birds.

Like the robin, another American bird seems to be on the verge of extinction. This is the national symbol, the eagle. Its populations have dwindled alarmingly within the past decade. The facts suggest that something is at work in the eagle's environment which has virtually destroyed its ability to reproduce. What this may be is not yet definitely known, but there is some evidence that insecticides are responsible.

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THE BIRDS

by Roger Tory Peterson
and The Editors of LIFE

TIME INCORPORATED
NEW YORK

A STONEHENGE BOOK

World War II our continental bird population has been reduced by many millions, by DDT and its more potent derivatives.

The tropics, rich in variety, seem to support more birds acre by acre than northern regions. Few tropical censuses have been taken except in Mexico, but it is my impression that in some of the scrub-covered grasslands in East Africa, particularly in southern Kenya, densities might well exceed 40 birds per acre.

Not every acre of land is blessed with nesting birds; we have been speaking of averages. Away from the polar icecaps, perhaps the largest areas of birdless country are such lifeless stretches as the Atacama Desert in Chile, lying between the coast and the high Andes, a 600-mile-long wasteland as sterile as an operating table. In the United States the Bonneville salt flats west of Great Salt Lake in Utah are certainly the largest birdless area.

Where would the world's highest density be? In the flamingo concentrations of the Rift Valley in Kenya and Tanganyika it is not exceptional to have more than a million lesser flamingos in one tight-packed, milling mass. But terns, cormorants and auks take up less space than flamingos. At Isla Raza in the Gulf of California 40,000 elegant terns may nest on a single acre; many eggs are but nine inches apart. Among land birds, the swarming colonies of queleas, or locust birds, in Africa defy description. These tiny weaver finches, which may gather in flocks of a million or more, recall tales of the passenger pigeons: they are so numerous that they darken the sky and break large limbs of trees when they settle. Farmers regard them as an agricultural menace and fight them with flame throwers and explosives.

What is North America's number one bird? Is it the house sparrow, introduced from England? Almost certainly not; the starling, less restricted to cities and farms, now outnumbers it. The American robin, however, is a more likely candidate than either. Found from coast to coast, it inhabits cities and forests alike and is one of the most abundant birds in the vast, 3,000-mile belt of conifers stretching across Canada to Alaska. Recently it has been suggested that the red-winged blackbird may be the most numerous bird south of the Canadian border. Nesting not only in every state but probably in every county, it seems to be having a population explosion. Winter roosts often number in the millions.

WHAT are the rarest North American birds? Two are so close to the void of extinction that their existence has been questioned in recent years. The Eskimo curlew, a shore bird with a slender decurved bill, was once abundant on the American plains during its passage from the Argentine to the arctic. Killed off for sport and for food before shore birds were removed from the game list, it went unrecorded for a number of years. However, in April 1959, a single bird appeared at Galveston Island on the coast of Texas and one was seen there the following two springs. In 1962 there were two; one was photographed.

The unadaptable ivory-billed woodpecker, North America's largest woodpecker, has not been recorded with certainty for some 10 years, but reports of it still persist and it is just possible that some are valid. The Everglade kite, a snail-eating hawk of the Okeechobee region of Florida, has numbered less than a dozen individuals in some years, the last of the species in the United States. From southern Mexico to Argentina, however, it is still found; it is even possible to see a hundred in a day's drive south of Buenos Aires.

There are now 39 whooping cranes in the world, seven of them in captivity. Each autumn the eyes of two nations, Canada and the U.S., are on the small surviving company of wild whoopers as they make the hazardous journey

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Jules

Hawk Mountain Sanctuary Association

Route 2

Kempton, Pennsylvania

News Letter To Members—No. 43

March 1971

Winter Scene from South Lookout

President's Message

Dear Member:

Each year the number of visitors to the Mountain continues to grow. Partly this may be because of our increased membership — now standing at 3,994 — and to greater interest in the birds of prey, but certainly it is principally due to today's general ecological awareness. This past year over 1,000 people came every month except the four winter months of January, February, March and December, for a grand total of 33,969, almost 5,000 more than last year's then record high. We welcome each and every one of them, although, unless you are there, it is difficult to conceive of the pressures on Alex, Fred, Dick and Barbara when 4,000 people pile in on one October weekend. We must soon come to a decision on how we are going to handle even more visitors in the future and still keep Hawk Mountain as the principal place in the east for checking the fall migration; for the visitors are sure to come.

Alex and Fred will cover the details of last fall's migration in their reports. Suffice it for me, therefore, to say only that the total hawk count was 24,000 — not a record but better than 1969 and, considering the poor winds and bad weather during the whole season, quite a remarkable count. There were record totals for Marsh Hawks and, again, almost unbelievably, for Ospreys — 600 compared to last year's high of 530. Our inland population of these birds must be steadily increasing, possibly due to less wintering ground competition from the DDT-ridden, dwindling coastal breeding birds.

In our Annual Report last fall we told you about our summer course in ecology under the leadership of Fred Wetzel. There is great demand for an expansion of this outdoor summer school — not only for more students from Reading, but also for the inclusion of boys and girls from other nearby communities. We are hopeful that within the limits of our capabilities we will be able to enlarge the attendance this year, even if only to a small extent.

Our annual membership appeal will be going out soon. Even though with the increased numbers of visitors and larger membership our revenues are up, so are the demands on us — and we urge you to renew your membership promptly and to ask others who are interested to join.

Best wishes to each of you.

Sincerely,

President

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Jules

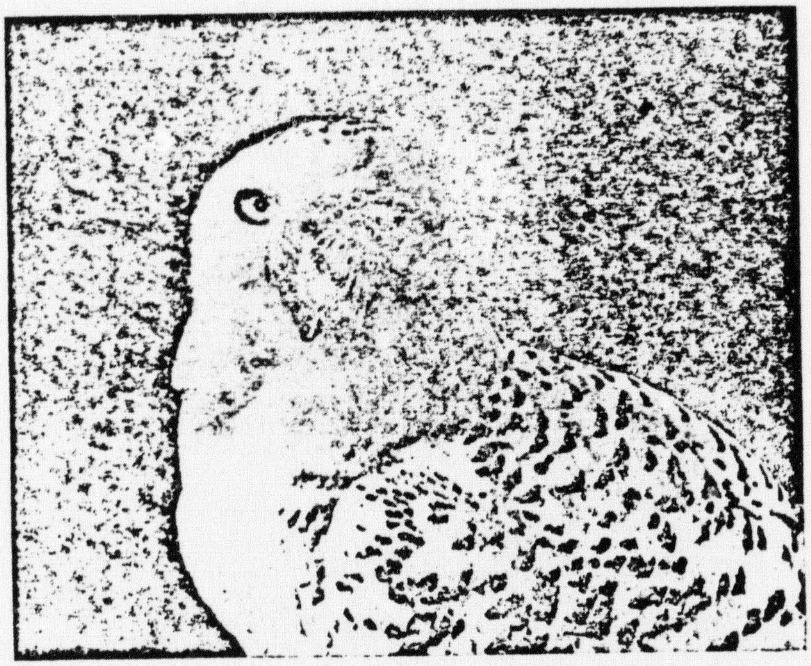
Hawk Mountain Sanctuary Association

Route 2

Kempton, Pennsylvania

News Letter To Members—No. 44

March 1972



Snowy Owl

A Cyclic Winter Visitor from the North

SUMMARY OF HAWK MIGRATION

Hawk Migration	*1970*		*1971*	
Goshawk	107		61	
Sharp-shinned Hawk	3,405		4,239	
Coopers Hawk	144		123	
Red-tailed Hawk	3,632		3,673	
Red-shouldered Hawk	350		400	
Broad-winged Hawk	14,372		11,573	
Rough-legged Hawk	18		23	
Golden Eagle	25	(14 im.)	35	(18 im.)*
Bald Eagle	28	(6 im.)	32	(4 im.)
Marsh Hawk	495		462	
Osprey	600		613**	
Peregrine Falcon	27		22	
Pigeon Hawk	23		22	
Sparrow Hawk	521		564	
Unidentified	253		335	
Total	24,000		22,177	

*This data is somewhat hazy due in part to a known immature Golden Eagle in the valley all season.

**Record — Previous high — 600 (1970)

Other migrants of interest . . . . . .

12,861	Canada Goose
88	Loon
50	Whistling Swan
25	Brant
3,994	Crow
1,486	Robin
210	Evening Grosbeak
235	Purple Finch
50	Red Crossbill
8	Rose-breasted Grosbeak
118	White-winged Crossbill
62	Pine Siskin
7	Red-breasted Nuthatch
264	Cedar Waxwing
2,503	Blue Jay
1,125	Red-winged Blackbird
1	Northern Shrike
10	Eastern Bluebird
15	Black Duck
21	Herring Gull
6	Great Blue Heron
38	Night Hawk
195	Hummingbird
11	Ruby-crowned Kinglet
6	Golden-crowned Kinglet
2,951	Chimney Swift
519	Barn Swallow
10	Cliff Swallow
58	Purple Martin

HAWK MOUNTAIN TOUR

We now have available for your home or club meeting, a revised packaged tour of the Sanctuary. Its highlights with special emphasis on the fall hawk flights are shown on 160 colored slides, each scene is supplied with commentary.

The slides are shipped in two standard Kodak carousel plastic trays, ready for use.

The photo tour will be sent on a rental basis, $15.00 plus $2.00 postage. Apply to the Curator, Hawk Mountain Sanctuary, Route 2, Kempton, Penna. 19529.

Credits for Photographs and Drawings: (by page numbers) (Cover), 5, 7, 10, 13, 14, 15, 16, 26, 28 — A. Nagy; 12 — Pennsylvania Department of Environmental Resources; 20 — Gary Micklus; 36 — J. Brett; 44, 45, 46, 47, 48, 49, 50 — Tom Mutchler.

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CLINICAL TOXICOLOGY, 2(4), pp. 359-370, December, 1969

Courtesy of Sponsors of Science
Box 4286
Madison, Wisconsin 53711

Editorial

DDT: The Chemical of Social Change

The story of DDT, like that of penicillin, starts with its military use in World War II. Some of the beginnings of this are described as follows by Still [1].

> By late 1943, Colonel William S. Stone was in North Africa. There he and Dr. Fred Soper, on loan to the Army from the Rockefeller Foundation, planned the anti-typhus campaign which, using DDT, smothered a typhus epidemic for the first time in all history—the outbreak which occurred in Naples during the war-winter of 1943-44.
>
> While Dr. Soper and his team had been perfecting the use of DDT as a weapon against louse-borne typhus, other biological scientists were studying its use as a weapon against mosquito-borne malaria. Malaria-control teams under Lt. Col. Justin Andrews were developing and learning the most efficient ways to spray DDT on mosquito breeding swamps and on their resting sites in buildings . . . At the same time airplane dusting equipment and methods were being developed by the Air Force. By spring-time when the malaria season began at Anzio, the counter-offensive with DDT and other anti-malaria weapons was ready. It proved to be as successful as the anti-typhus campaign in Naples and our troops were able to survive until they became strong enough to break the German encirclement and resume the attack. Without DDT, this military feat would have been unthinkable.
>
> In the ensuing campaign ending in the capture of Rome, DDT enabled the allies to fight through the Pontine marshes without being decimated by malaria as previous armies had been. Thus Rome was captured from the south for the first time in history.

The rapid spread of DDT to peacetime purposes came before the surrender of Germany, and was initiated by the U. S. Army. Simmons [2] has

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graphically described the use of DDT in preventing a European pandemic of typhus in 1945 following the liberation of the survivors from Hitler's extermination camps, in which typhus was rife. The liberators wiped out the disease by profusely dusting all the inmates with DDT, without filing new drug applications.

Even before this, in 1944, malaria was being fought to help civilians in the Mediterranean basin. Still [1] describes the work of Colonel Paul Russell and Dr. Soper, under the auspices of military government, in using DDT in Egypt, Cyprus, and Sardinia, the latter two of which are now free of malaria.

By these pioneering achievements, the U. S. Army added to the luster which embellishes the contributions by Major Walter Reed and his collaborators in the conquest of yellow fever at the turn of the century. Indeed, the number of lives saved by DDT in the following twenty years was probably as great as the number killed by the Nazi armies in World War II.

With rapidity unprecedented in the annals of public health, the use of DDT made inroads on insect-borne diseases that had scourged the human race for many centuries and in many lands. The etiology of these diseases had enabled them largely to escape the conventional control methods which are based on bacteriology. The new target was the insect world. Devastating and prolonged effects on mosquitoes were brought about by spraying DDT on the interior walls of dwellings. The insecticidal residues remained on the walls for several months, and the life cycle of the malaria parasite was broken.

A campaign to eradicate malaria was planned and carried out by the WHO. The program is based on DDT. Strengthened by various governmental measures which are centered on DDT, the WHO campaign has resulted in the disappearance of malaria from many regions and in great inroads against other important diseases that are vectored by arthropods. Sir MacFarlane Burnet commented, 16 years ago, on the consequences of eradicating malaria as follows:

> If we take as our standard of importance the greatest harm to the greatest number, then there is no question that malaria is the most important of all infectious diseases. All over the tropical and subtropical zones, wherever there are aggregations of people, there malaria flourishes. In India it is calculated that about a hundred million people are infected with the parasite responsible, and that about two million deaths per annum are directly due to malaria. The influence of the disease extends far beyond its obvious activities as a cause of

> death and serious illness. It is the great devitalizer of the tropics—much of the backwardness of the Indian peasant has been ascribed to malaria—and it is the main agent of infantile mortality. If malaria could be suddenly eliminated from the globe, the racial, economic and political consequences within a very few years would probably be appalling. India and parts of Africa are populated up to and beyond the capacity of the land to provide adequate food by present methods, and even with the tremendous infantile and prenatal mortality caused by malaria, the populations are increasing steadily. The sudden conversion to a more vigorous and rapidly increasing population would undoubtedly produce famine, (emigration) and intense internal and external social repercussions [3].

The predicted repercussions have now arrived and, ironically enough, some Americans, by demanding a ban on DDT, are reversing the traditional role of their country in relieving the suffering of others.

The rapid growth of the human population has brought endless irritations, difficulties, and even catastrophes in its wake. It has also engendered vigorous protests by people, as individuals, against people *en masse*. With this has come a change in social attitude by some human beings who, not without justification, now regard their own species as one which destroys its own habitat and that of its fellow creatures. This attitude was enhanced by the fear that characteristically accompanies a lack of understanding. It may be illustrated by the violent reactions against fluoridation of the water supply, and by the statement made to me by an eminent photographer that he had an instinctive feeling that pesticides were bad for him. A third factor was the fact that agricultural technology, including the use of pesticides, has increased the efficiency of farm operations so much that an American farmer now feeds 30 people. The city-dweller came to live in a cloud-cuckoo-land where food grows in supermarkets; and his children grew up ignorant of the toil necessary to raise crops.

The climate thus became favorable in 1962 for these reactions to be expressed in the book "Silent Spring" [4], and for its enthusiastic reception by many of the urban public. One million copies of the book have been sold. It attacks the use of pesticides as menacing wildlife and human beings, and omits mention of the role of DDT in liberating millions of people from debilitating or fatal diseases. The text is interlarded with dire allegations such as "For the first time in the history of the world, every human being is now subjected to contact with

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dangerous chemicals, from the moment of conception until death." The second part of the sentence always has been true, but the first clause is completely erroneous. The danger of chemicals, of course, depends on dosage rather than identity, but this fact is difficult for the average person to grasp when it is obscured by alarming rhetoric.

Strident demands are currently being made that DDT be banned. Two broad reasons are used to support these demands: first, that DDT is polluting the environment and destroying beneficial forms of wildlife as well as pests; second, that the use of DDT is dangerous to human beings, so that it threatens them with cancer and inability to reproduce. Both reasons are advanced by many members of the wildlife protection groups, including the Environmental Defense Fund, also by certain members of Congress and State Legislatures, who have introduced "ban" bills. The expertise in toxicology that has descended on botanists and ichthyologists has been impressive indeed. They have not hesitated to predict that the human race faces extinction by DDT on the basis of extrapolation from auguries such as alleged difficulties in survival which have been faced by the Bermuda petrel for a century, and (we are told) are reaching a climax. An official of the National Audubon Society, trained in ornithology, is dispensing recommendations on pesticides to replace DDT, including nicotine sulfate, which is at least 300 times as lethal as DDT. An environmental Ann Landers, this official also offers literature, consisting of "Ban DDT" bumper stickers, to his fans.

Astute statesmen have realized that DDT is a motherhood issue, and have reacted accordingly. Undoubtedly the major factor in making decisions on DDT has been public pressure; generated mainly by scare newspaper articles, announcements by famous T.V. commentators, and publicity by societies for the protection of wildlife.

THE WILDLIFE MYSTIQUE

Emotional attitudes toward species other than our own are greatly influenced by a rigid set of conventional esthetic values. Some of the more successful birds, such as the starling, are regarded as objectionable because they displace species that are less adaptive. The greatest admiration is held for predators, such as the peregrine falcon, which, when on a spree, kills far larger numbers of other birds than it needs for food. Its habits have been termed "noble" [5]. Yet the starling shows us a model of resourceful and thrifty family life, as it moves into our cities to share our company, and forages industriously for sumach berries in the dead of

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winter. Heedless of the prophets of doom, about eight million starlings entered into Fresno County, California, during the period 1942 to 1962. Fresno County uses more pesticides, probably, than any other county in the U.S.A. The starlings are thriving all too well.

Chapter 8 of *Silent Spring* clearly states that many species of birds are disappearing rapidly. The conclusion is based on such scientific findings as a report by an observer who saw "no land birds at all for long distances" while driving in southern Mississippi in the fall. An attempt has been made [6] to assess these charges, per observer on the basis of actual bird counts made by volunteers, and summarized by the National Audubon Society. The analysis is on Table 1, which compares the counts in 1941 with the results in 1960, fifteen years after the introduction of DDT. The table has been abbreviated from the compilation by Marvin, but no species have been omitted which showed a reduction per observer. The average total bird count per observer, including all the species listed originally by Marvin, was 1,480 in 1941 and 5,860 in 1960. Yet the nonsensical recital in *Silent Spring* continues to be published in repeated printings without modification.

The fables about the disappearance of swallows ("Our sky overhead was full of them only four years ago. Now we seldom see any") and the nearly extinct robin [4] are particularly ludicrous when viewed in the light of Table 1. Yet this mythology is now firmly entrenched in the folklore, where it has been reinforced by conclusions made by Wurster [7], who observed a few dead robins in Hanover, New Hampshire after the spraying of elm trees with DDT, as follows:

> "Since the study areas represented 2¼% of the sprayed part of town, and the May 1 resident population on these areas average 12 Robins, the total Hanover Robin population was approximately 500 to 550. Based on a 70% decline in the study areas by June 1, total Robin mortality in Hanover was about 350 to 400 birds."

From these humble beginnings, extrapolations have been made into postulating millions of dead birds. The possibility that the 70% decline in the study areas was due to 7 robins taking a trip out of town seems to be ignored.

Actually, there is little or no evidence for a decrease in the numbers of land birds attributable to DDT. The probability is strong that increases in the numbers of certain species of common birds, such as redwing blackbirds, may have resulted from the destruction of insect vectors of bird diseases.

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Table 1
Audubon Society Christmas Bird Count Data[a]
1941 (2,331 observers) vs. 1960 (8,928 observers)

Species	Count		Count/Observer		Ratio per Observer
	1941	1960	1941	1960	1960/1941
Eagle	197	891	0.08	0.10	1.25
Gull	124,470	635,642	53.40	7.20	1.33
Raven	667	2,699	0.29	0.30	1.03
Crow	185,519	250,307	79.59	28.04	0.35
Quail	2,060	10,276	0.88	1.15	1.31
Pheasant	6,839	19,731	2.93	2.21	0.75
Mourning dove	7,411	72,958	3.18	8.17	2.57
Swallow	14,347	242,303	6.15	27.14	4.41
Grebe	2,501	27,826	1.07	3.12	2.92
Pelican	4,450	10,562	1.91	1.18	0.62
Cormorant	3,246	27,162	1.39	3.04	2.19
Heron	2,254	16,253	0.97	1.82	1.88
Egret	1,469	16,800	0.63	1.88	2.98
Swan	18,554	33,994	7.96	3.81	0.48
Goose	182,820	696,777	78.43	78.04	0.99
Duck	2,137,093	2,739,517	916.81	306.85	0.33
Blackbird	137,502	20,552,375	58.99	2,302.01	39.02
Grackle	24,937	12,570,458	10.70	1,407.98	131.59
Cowbird	40,019	3,286,314	17.17	368.09	21.44
Chickadee	21,330	55,906	9.15	6.26	0.68
Titmouse	5,038	18,268	2.16	2.05	0.95
Nuthatch	4,214	13,439	1.81	1.51	0.83
Robin	19,616	928,639	8.41	104.01	12.37
English sparrow	53,335	358,796	22.88	40.19	1.76
Bluebird	3,742	6,903	1.60	0.77	0.48
Starling	211,836	8,673,095	90.88	971.45	10.69

[a] 42nd Christmas Bird Count, *Audubon Magazine*, 1942; 61st Christmas Bird Count, *Audubon Field Notes* 15: 1961.

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There is some indication, however, that some fish-eating birds are showing a depressed reproductive performance, accompanied by storage of DDT. This evidence is inferential, but justifies rigorous precautions to monitor the use of DDT where it may drain into rivers, lakes, and bays.

Much publicity has been given to the finding that chlorinated hydrocarbons, possibly including compounds that are not pesticides, have produced thinning of eggshells and interference with reproduction in certain birds [8].

Other birds, however, do not show this; Bengalese finches receiving DDT laid eggs with shells thicker than those of controls [9], and high levels of DDT did not interfere with reproduction in chickens or quail [10,11]. Generalizations on this subject are unwarranted; the evidence is that DDT may increase, decrease, or have no effect on the thickness of eggshells, perhaps depending on the species of birds.

Undoubtedly pesticides, like other human interventions, produce changes in the environment, and in the relative numbers of different wild species. The assessment of the effects of DDT is obscured by exaggeration, misinformation, and an insufficiency of controlled observations. A sober evaluation of the available information is badly needed.

It is pleasant to note that a record number of 373 bald eagles, 120 of which were immature (i.e., less than four years old) were counted on November 20, 1969, at Lake McDonald and McDonald Creek in Glacier National Park [19]. Defying the prophets of his chemical doom, our national emblem is evidently reproducing at his normal rate in parts of North America where he is not harried, chased, and shot at by tree-choppers, real-estate developers, and "sportsmen," who pass the buck to DDT. *Viva las águilas!*

CANCER, MUTATIONS, STERILITY, AND TERATOLOGY

Many lovers of nature have responded with great intensity to the crusade against DDT that has been mounted by organizations dedicated to the defense of wildlife. However, stories about birds, no matter how colorful and emotional, do not appeal greatly to large numbers of voters. Much better mileage can be obtained by telling the public that the food in the supermarket will give them cancer or make them sterile. This appeals to the two basic drives: self-preservation and species-preservation. Campaigns against DDT are therefore usually characterized by planting implications that it is carcinogenic, or sterilizing, or both. In recent months, the tempo has been stepped up, as proposed laws to ban DDT come close to enactment, and the extinction of the entire human race by DDT is sometimes predicted in newspaper articles, presumably as an incentive to get voters to write to their legislative representatives.

It is astonishing that so few voices are raised against this noisy propaganda, which began in the Police Gazette [12] and was continued in *Silent Spring*. The facts, of course, are that not a shred of evidence is available to show that overexposure to DDT is accompanied by an increase in the incidence of cancer in human beings. Hays [13] has reviewed much of the clinical information on DDT without finding any indications for carcinogenicity in human beings. Negative results came from the study of the Montrose Chemical Company workers who had been exposed to 400 times the "usual" level of DDT continuously for periods up to 19 years.

The argument regarding reproduction usually states that changes in steroid hydroxylase have been detected in homogenates of the livers of rats on low levels of DDT, and that the "thin eggshell" phenomenon indicates that DDT conceivably can interfere with human reproduction. However, reproduction is measured by the appearance of viable offspring. Rats reproduce normally on high levels of DDT [14]. Human beings seldom lay eggs, except figuratively. The trick of extrapolating from one species to another, without experimental data, is contrary to the fact that the use of DDT is based on the principle of comparative toxicity, which depends on the fact that DDT is more toxic to certain species than to others, as shown by a vast amount of data [13,15].

The omission of a *quantitative* approach to the toxicology of DDT is a serious defect in many statements. The detection of a few parts per billion of DDT is possible by vapor phase chromatography, and the presence of such minute traces is frequently used to arouse, quite unjustifiably, the fears of the public. The fact that DDT is stored in fatty tissue produces a popular impression that DDT is a "cumulative poison" that goes on increasing as long as any is taken in. Hayes [13] has stated:

> "People trained in the biological sciences are generally familiar with the fact that compounds which are absorbed tend to reach a steady state of storage and that for each compound the storage at equilibrium corresponds to dosage. People not trained in the biological sciences are usually unfamiliar with these facts and suppose that compounds are of two distinct sorts, those that are stored and those that are not. They suppose that compounds that are stored at all continue to accumulate indefinitely with no tendency to reach a steady state in which the amount lost each day

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is equal to the amount absorbed. It may seem odd to mention this folklore . . . , but the views of the public are a most important factor, which must be taken into account in any long-term effort to achieve general public acceptance of a particular usage or course of action."

The use of implication to arouse public distrust of pesticides is deplorable, because our society is dependent on pesticides for its health and food supply. Careful monitoring of the pesticide content of foods, carried out continuously by the Food & Drug Administration, has consistently shown that pesticide residues in the American diet are far below the tolerated level, which itself has about a hundred-fold margin of safety between it and the LD_{50}.

DDT–THE CHEMICAL OF SOCIAL CHANGE

The use of DDT in controlling pestiferous insects help set changes in motion that have had world-wide effects. Through untold centuries, millions of human beings have shared their lives with that of a blood-sucking insect, the mosquito, which infested them with a parasite, the plasmodium of malaria, that destroys red blood cells. Such is the "balance of nature." Malaria is so universal in the tropics that it has affected human molecular evolution. A deleterious mutation, "sickle cell hemoglobin", has spread widely because people with a heterozygous inheritance of this defective character have malformed red blood cells which resist the malaria parasite. The genetic defect has conferred a survival advantage. DDT has the potential of driving out sickle cell anemia by population genetics.

Following the introduction of DDT, malaria was swiftly reduced in many countries. The improvement in health produced the surge in human activity that comes with renewed strength. Increased agricultural and industrial productivity in India, resulting from control of malaria, has been estimated as worth one billion dollars annually. In many countries, areas, previously uninhabitable, were made into prosperous farms. The reduction in infant mortality brought the population explosion, with its attendant social unrest and violence, and Still has pointed out that DDT shares the credit for the political ferment [1].

The second sociological change hastened by DDT and its congeners was accelerated migration to the cities as a result of increased agricultural production by modern technology, especially the use of pesticides. The new city-dweller lives on food that can be grown in adequate supply only with the aid of pesticides.

The opponents of DDT usually make a perfunctory acknowledgment

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that DDT was once useful against malaria and typhus, or that it had an important role in World War II, etc., but that it can now be replaced. The physicians in the World Health Organization, who have day-to-day experience with malaria control, tell a different story. Dr. Guzman Garcia-Martin, Chief, Malaria Eradication Department, WHO, said on June 10, 1969 [17], 4

> "The withdrawal of DDT would mean the interruption of most malaria eradication programs throughout the world . . . . DDT has been the main weapon in the world-wide malaria eradication program. Research has continued for the development of other methods of attack against malaria and for the development of alternative insecticides. To date, there is no insecticide that could effectively replace DDT which would permit the continuation of the eradication program or maintain the conquests made so far . . . . The withdrawal of DDT will therefore represent a regression to a malaria situation similar to that in 1945. The reestablishment of malaria endemicity would be probably attained following a period of large scale outbreaks and epidemics which would be accompanied by high morbidity and mortality due to loss of immunity by population previously protected by eradication programs . . . . The use of DDT in malaria eradication, i.e. by the spraying of the inner surfaces of houses, has little opportunity of contaminating the environment and bringing any considerable amount of DDT into the food chain . . . . Toxicological observation of spraymen working for a number of years in malaria eradication and even in formulation plants, has not revealed toxic manifestations in them. Neither, has there been any evidence of toxicologic manifestations in people residing in houses that have been repeatedly sprayed at six month intervals . . . . Among organophosphorous insecticides only malathion, fenthion, dichlorvos and fenitrothion have been used in large scale trials to test their ability to interrupt malaria transmission. All others had to be discarded before embarking on a large scale field trial in view of their toxicity or poor effectivity on malaria vectors . . . . From these only malathion could be recommended for use in malaria eradication but due to its high cost and short residual effect its use has been limited to the protection of some of the areas where DDT resistance is present . . . ."

The Department of Vector Biology and Control, WHO, Geneva, in a statement [18] released on August 18, said that DDT

"still provides the most effective, cheapest and safest means of abating and eradicating malaria, and this remains true despite the development of a DDT-resistance which is not insuperable . . . . It is so safe that no

> symptoms have been observed among the spraymen or among the inhabitants of the spray areas, which numbered respectively 130,000 and 535 million at the peak of the campaign. DDT as applied has not caused any side-effects among domestic animals . . . . No side-effects have been observed in the wildlife of the countries participating in the campaign . . ."

and that DDT has been

> "the main agent in eradicating malaria in countries whose populations total 550 million people, of having saved about 5 million lives and prevented 100 million illnesses in the first 8 years of its use, of having recently reduced the annual malaria death-rate in India from 750,000 down to 1500, and of having served at least 2 billion people in the world without causing the loss of a single life by poisoning from DDT along . . . ."

Like James Joyce's sow that eats her farrow [16] men now seek to destroy the methods that they have brought forth.

There is a widespread and vague feeling that "something is wrong." Perhaps man cannot understand how precious food is unless he has to toil to produce it himself. Perhaps he cannot appreciate freedom from infectious diseases unless he sees their devastating effects before his own eyes. The age-old enemies of the human race, starvation and sickness, are making ready to halt their retreat as our legislators prepare to ban DDT, the chemical of social change.

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with compliments

Thomas H. Jukes

ENVIRONMENTAL AFFAIRS

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"DDT, HUMAN HEALTH AND THE ENVIRONMENT"

BY

Thomas H. Jukes

Environmental Law Center
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DDT, HUMAN HEALTH AND THE ENVIRONMENT

*By Thomas H. Jukes**

For the past two years there has been an intensive campaign to ban the insecticide DDT (dichlorodiphenyltrichloroethane) from use in, manufacture in, and export from the United States. This article evaluates the evidence for some of the charges in this campaign. These include charges that DDT is a "biocide" (a name implying that it is poisonous to all forms of life), permeates the environment, is virtually indestructible, kills many desirable forms of wildlife, and is dangerous to human beings. The last of these claims is particularly astonishing in view of the fact that DDT has saved millions of human lives from malaria, typhus fever, plague and other deadly diseases without harming a single person, except in a few cases of accidental or suicidal overdosage.

The propaganda against DDT has been so extensive and successful that DDT is now widely regarded by the public as a dangerous poison. There have been a series of newspaper cartoons, skillfully staged television shows, and a display of bumper stickers with skull and cross bones, all aimed at exposing the evils of DDT. The National Audubon Society printed 700,000 copies of a leaflet urging that the export of DDT be stopped. This leaflet was distributed at about the same time a resolution requesting the continuation of the use of DDT was passed at a meeting of the WHO Regional Committee for Southeast Asia held in 1969 in Nepal, attended by representatives of eleven tropical countries totaling over 700 million in population—about 1000 people for each Audubon leaflet.

Many people have become self-constituted authorities on DDT as a result of exposure to mass media. For example, the chief judge of the Circuit Court of Appeals in Washington, D.C., an-

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nounced in January, 1971, that DDT kills honeybees and is dangerous to people. Yet, while other insecticides, such as parathion and Sevin, do kill bees, DDT's effect on these insects is only minimal. As regards DDT's effects on people, the principal consequence has been to increase population, not endanger lives.

What are the facts of this strange paradox? What motivates those who crusade against the most useful chemical in history? Is the attack on DDT partly directed against its role in accelerating the population explosion?

The organizations that are most active in the movement to ban DDT include some of the large conservation groups. Despite the size of some of these groups, they do not speak for all segments of the population. Some environmental groups, in fact, have recently been challenged by organizations which represent racial minorities. As the following statement suggests, the needs of the urban poor are not likely to be assuaged by the Thoreau-like preoccupations of many of the conservation associations:

> In general, black people probably do not know much about the science of ecology or the study of human conservation as now offered in most universities. Probably they know very little about bay fill, polluted streams, soil erosion or redwood trees. And probably they couldn't care less. But precisely because they are black and poor, they do know a great deal about 125th Street in New York, about South Street in Philadelphia and the Fillmore in San Francisco. About those environmental disasters they are very knowledgeable and they can also tell you quite a bit about human conservation as practiced on any of those nearby street corners, in the filthy two-, three-room walk-ups, in the fetid housing projects or in their urine-, vomit-, whiskey-, blood-stained hallways which exist all over, everywhere, in the uninhabitable cities of America's enraged and inconsolable slum communities.[1]

The National Audubon Society, which appears to have a predominantly white and middle-class membership, is one of the most active anti-DDT organizations. For a member to condone the use of pesticides would be tantamount to the deepest heresy in a religious sect. For an official of the Society to approve such use would be fiscal lunacy, in view of the tremendous amount of free publicity that the Society has received as a result of *Silent Spring*[2] and other publications which have established a new mythology—the extermination of wild birds by agricultural pesticides. The Society shows underlying resentment of human beings and all their works, including cities, farms, highways, and especially private industry. Membership in the Society is a form of expiation of the sin of being one of the human race, the species that consumes "the environment". The Society stated recently that one of its two main purposes is "the education of man regarding his relationship with and his place within the natural environment as an ecological system."[3] This pious pronouncement is actually intended to exclude man as an inhabitant of the Earth, except in small numbers and in a primitive, mythical, aboriginal state. The Audubon Society has no program for the relief of suffering among millions of human beings in the tropics.

Two other organizations that have attacked DDT are the National Geographic Society[4] and the Sierra Club. The National Geographic Magazine advertises plush overseas tours for the wealthy people. The magazine has beautiful photographs of wild animals, birds, and under-dressed natives in picturesque attitudes. These pictures do not show the ravages of tropical diseases that can be controlled by DDT. The Sierra Club, which is seeking legal action to obtain a ban on DDT,[5] also features expensive outings to remote lands, again largely for the healthy and economically secure. The motivation of conservation organizations is primarily to protect the landscape and its wildlife. This may be in conflict with combatting hunger and disease in human beings.

Why is it necessary to defend DDT? Why can't other insecticides be used instead? The answer is that DDT is specifically needed to protect millions of people in tropical countries from death by malaria. This has repeatedly been made plain by the World Health Organization in statements such as the following:

> The withdrawal of DDT would mean the interruption of most malaria programs throughout the world. . . . DDT used as a residual spray of the interior surface of houses. . . led to the idea of nationwide malaria control campaigns including the whole of the rural areas of a country. The success of these campaigns resulted in the concept of malaria eradication which was adopted. . . for the world by the Eighth World Health Assembly in May, 1955.
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> Since then DDT has been the main weapon in the world-wide malaria eradication program. Research has continued for the development of other methods of attack against malaria and for the development of alternative insecticides. To date, there is no insecticide that could effectively replace DDT which would permit the continu-

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> ation of the eradication program or maintain the conquests made so far.
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> The withdrawal of DDT will therefore represent a regression to a malaria situation similar to that in 1945. The reestablishment of malaria endemicity would be probably attained following a period of large-scale outbreaks and epidemics which would be accompanied by high morbidity and mortality due to loss of immunity by population previously protected by eradication programs.
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> Toxicological observation of spraymen working for a number of years in malaria eradication, and even in formulation plants, has not revealed toxic manifestations in them or in people residing in houses that have been repeatedly sprayed at six month intervals.
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> We therefore believe that a great harm will result from the unqualified withdrawal of DDT. We feel that selective use of DDT is justified and warranted.[6]

This is what the argument is all about. If the manufacture and export of DDT are banned in the United States, the world-wide antimalarial program will collapse. Most of the DDT manufactured in the United States is for this program. Furthermore, a ban in the United States would lead to prejudice against the use of DDT elsewhere.

Those who are fighting the ban are struggling to save lives. The objective is not to "protect the chemical industry," since the substitute insecticides are more expensive and more profitable than DDT. These substitutes can be used, with varying degrees of lower efficiency, against the agricultural pests that are controlled by DDT. But there is no effective substitute for DDT in the world-wide campaign against malaria. The other compounds either decompose rapidly, produce resistance too fast, or they are too poisonous to people.

TOXICOLOGY

There is a saying among toxicologists that this subject can be easily learned in two lessons—each five years long.

One of the oldest principles in toxicology was stated by Paracelsus almost 500 years ago: "Everything is poisonous, yet nothing is poisonous." This is quite familiar to biochemists, who recognize that several chemical elements commonly regarded as poisonous are essential in small amounts to life. Examples of these are copper, chromium, manganese and selenium. The last named of these is also carcinogenic (*i.e.*, tends to produce cancer). Traces of practically all the elements can be detected by spectroscopic tests in most biological materials, and all living creatures contain radioactive carbon and radioactive potassium. The crucial matter is the quantity of such substances that we consume in proportion to the amount that is toxic. It is comparatively easy to poison animals with table salt in high dosage.

The development of modern analytical methods of sensitivity has enabled many substances to be detected in concentrations of less than one part per billion (ppb). If the substance thus detected is commonly regarded as a poison, then the detection of such traces in unexpected places may cause public alarm, especially when the news is presented in a sensational manner. The claimed detection of DDT in Antarctic penguins at levels in the range of one part per billion has been used to imply that the whole world has been poisoned. The finding actually shows that molecules can be dispersed widely, and that the analytical device known as vapor phase chromatography, or electron capture, is extraordinarily sensitive. Such procedures can easily give erroneous results if substances are present which simulate the compound whose measurement is sought. The analysis must be carried out by an expert, or better, by two or three experts working independently, if reliable results are to be obtained.

Another basic concept of toxicology was stated by Lucretius two thousand years ago: "Quod cibus est aliis; aliis est acre venenum"—"One man's meat is another man's poison." The scientific application of this proverb is known as comparative toxicity; it is a keystone of therapeutic medicine. A significant goal of researchers in the area is easily understood in terms of the metaphor of the "magic bullet."[7] Drug therapists have continually searched for chemical "magic bullets" which hit disease carriers while missing patients. DDT is such a "magic bullet" because it kills mosquitoes and other insects that carry disease, but does not injure human beings. The idea of the "magic bullet" is more precisely expressed by the therapeutic ratio, which is the fraction of the minimum lethal dose of a drug that is therapeutically effective. The smaller the fraction, the safer the compound is for general use.

Research in comparative toxicity has led to the discovery and development of chemicals, such as antibiotics and pesticides, which enable the human species to compete successfully with other forms of life, especially disease organisms. Although it is *possible* that advances in comparative toxicity will contribute to a serious overpopulation in man, it is *certain* that inattention to this field of knowledge will permit a critical fall in global food supplies and global public health.

Malaria

From time immemorial human beings have been hosts to a genus of protozoa known as *Plasmodia*. There are many species in this genus; three of the principal ones that attack human beings are *Plasmodium vivax*, *P. malariae*, and *P. falciparum*. They produce respectively three different types of malaria. Of these, the most malignant is that produced by the *falciparum* species, which often attacks the brain. These three Plasmodia spend part of their life cycle in mosquitoes, but the cycle is not complete without going through several stages in man, where they reach maturity in the red blood cells and reproduce, in enormous numbers, into a form called *merozoites*. These change into the sexual stage, which enters the body of a blood-sucking mosquito. Other stages of the life cycle then take place, and the parasite reaches the salivary gland of the mosquito, from which it is inoculated into the next victim bitten by this insect. The cycle then continues from man to mosquito, and mosquito to man. The principal method for breaking this pernicious chain is to kill mosquitoes with DDT by spraying the interior walls of human dwellings.

Public health authorities in the tropics apparently use a figure of 1 per cent per year to estimate the mortality from malaria; thus 75 million cases in India in one year were calculated to be responsible for 750,000 deaths.[8] The survivors in many cases are severely debilitated and unable to work.

The mosquitoes rest on the walls by day and attack sleeping people at night. If DDT is sprayed on the walls, it kills the mosquitoes. An insecticide for this purpose must be *persistent* because it is not possible for spray teams to go into the same house frequently. Malathion, for example, is non-persistent and soon decomposes; it also has a pronounced and offensive odor. The procedure must be *safe* to those dwelling in the house, and to the sprayers, who are intensively exposed to the insecticide. The development of resistance by mosquitoes to the insecticide must be slow enough to enable the life cycle of the mosquito to be broken. DDT as opposed to lindane, for example, fulfills this requirement. Note that the WHO program favors spraying walls to kill adult mosquitoes rather than spraying ponds and swamps to kill larvae.

I have not mentioned cost, because this should not be a prime consideration when many human lives are at stake. However, Russell estimates that the appropriations of the United States for overseas malaria control and eradication amounted to a half-billion dollars in the past 25 years.[9] As a result of international cooperation, WHO has maintained an effective world-wide malaria eradication program:

> Today more than 960 million people who a few years ago were subject to malaria endemicity are now free of malaria; another 288 million live in areas where the disease is being vigorously attacked and transmission is coming to an end. Because much of Africa remains highly malarious and because about 288 million people live in malarious areas not yet subject to eradication measures, it is logical that the United States should maintain an active interest in this disease.[10]

These estimates by Dr. Russell indicate that the United States contribution to saving lives from malaria has paid off quite well in terms of human welfare. As I said recently however, "some Americans, by demanding a ban on DDT, are reversing the traditional role of their country in relieving the sufferings of others."[11]

DDT in Agriculture

Insects compete with mankind for food. They devour all parts of plants—leaves, stems, fruits and seeds. A plant attacked by insects will often die without producing seeds or fruit. The vulnerability of plants to attack by insects is greatly increased by agriculture, which inevitably leads to what is called "monoculture"—the growing of a single crop in a large area of land, such as a field. Obviously a group of crop plants, such as potatoes, corn, tomatoes and alfalfa, cannot be grown as a mixture. Food must be grown on farms using monoculture, unless and until some other method of providing nourishment is developed.

Prior to World War II methods of controlling agricultural pest insects included the use of "stomach poisons", the most effective of which was lead arsenate; the use of contact poisons, *e.g.*, nicotine sulfate; and the use of hand labor, *e.g.*, for burning cornstalks and plowing them underground in the fall to control the European corn borer, or for picking bugs off potato plants. The discovery of DDT revolutionized the control of agricultural insects. It also replaced lead arsenate, which is virtually indestructible, and highly toxic.

DDT is intensely poisonous for many insects, and is less toxic for plants and warm-blooded animals. Like all chemicals, however, DDT has a level of toxicity for any species of animal or plant. The extensive use of DDT, without adequate controls, has resulted in the killing of non-target species. In some instances this was an accepted risk. For example, when forests were sprayed to control the spruce budworm, many fish were killed in the streams. These were replaced by planting other fish.

DDT is poisonous to crustacea, such as crabs. Careless use of DDT and other pesticides that results in their drainage into rivers, swamps, lakes, estuaries and coastal waters must not be allowed. This precaution would remove a major source of friction between agriculture and those who are interested in wildlife. Actually, a rapid reduction is currently taking place in the agricultural use of DDT, and this will undoubtedly lead to a lessening of its movement through "food chains," which concentrate fat-soluble substances. However, if DDT suddenly disappeared this would not end the problem. Most of the fish that are killed by pollutants in inland waters are the victims of petroleum wastes, industrial wastes and sewage, just as most eagles found dead are killed by gunfire. The role of other pollutants is just beginning to emerge.

Solubility in fats is not an exclusive property of DDT or of the other pesticides that are similar to it. Recently it has been found that mercury can be converted into a fat-soluble form, methyl mercury, by bacteria. This form can enter food chains and, by stepwise concentration, produce effects that are toxic to animals and birds that eat fish. Mercury has been present in sea water ever since the oceans were formed, and occurs in the earth's crust. It does not become a problem until its concentration is greater than the toxic level. This level can result from industrial contamination, but the possibility exists that such levels also occur under natural conditions.

Space does not permit an adequate discussion of the vast topic of the effect of chemicals on wildlife. Many of the conclusions are based on inferences, rather than on controlled experiments. There arise therefore ambiguities, which lead in turn to disputes. The final answer may differ from the first guess. It is thus best to react cautiously to preliminary judgments regarding the death or disappearance of wildlife. For example, a few winters ago robins were unusually scarce in the coastal cities of California and DDT was blamed widely. The robins were actually back in the mountains, feeding on an unusually fine crop of berries, and the following winter they were in town as usual.

How to Alarm the Public—A Study in "Eco-Tactics"

A syndicated newspaper article has described the history and activities of the Environmental Defense Fund (EDF), asserting that the EDF "has swiftly become the public defender of the environmental movement." The article stated that

> The turning point came when Cameron decided to spend about $5,000 of the organization's total remaining assets of $23,000 on an advertisement in the New York Times on Sunday, March 29, headlined 'Is Mother's Milk Fit for Human Consumption?' It referred to the amounts of DDT in the human body.
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> The ad appealed for members, starting at $10 for a basic membership. It produced $7,000, a profit, and the EDF turned to a direct mail campaign and now has 10,000 members, a stable financial base and a chance at major foundation support.[12]

This is a most interesting revelation. The EDF appealed to the public on the basis of the DDT content of human milk. As a means of arousing alarm concerning DDT, the EDF and the National Audubon Society have both stated that DDT causes cancer. The implication that DDT in breast milk may cause cancer in babies is superlatively sensational copy. The following lurid passage is from an article by Ed Chaney, Information Director, National Wildlife Federation:

> A five-day-old human being lies asleep in the other room. His name is Eric. His tiny, wiggly, red body contains DDT passed on to him from his mother's placenta. And every time he sucks the swollen breasts, he gets more DDT than is allowed in cow's milk at the supermarket. Be objective? Forget it. Objective is for fence posts. How can you be objective in the face of a global insanity that is DDT? In the face of abdicated responsibility by the men the public pays to protect its interests. Are the anarchists right? Are ashes the only fertile seed bed for growing new responsiveness to the public interest? Picture a swarm of angry citizens bathed in the light of flames engulfing the Agriculture Department.[13]

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It is distressing that an official of a large organization should discard objectivity and propose anarchy in its stead.

Let us examine the factual and scientific background for the propaganda campaign regarding DDT in human milk. The background starts with the improvements in technology that made it possible to detect fantastically small quantities of DDT. Note that such extremely delicate tests can easily give "false positive" readings because of accidental contamination of the equipment or lack of expertise by the tester. We must next note that cows' milk has occupied an unusual position among foods with respect to regulations. "Zero tolerance" has been the policy with respect to additives to milk, except for vitamin D. The improvements in testing procedures made it necessary to re-examine the definition of zero, since every chemist knows that zero content, in molecular terms, does not exist. For example, all fish and all human beings have contained mercury for millions of years (*i.e.*, before the chemical industry existed). To get back to milk, more than ten years ago it was evident that the entire canned milk stocks of the United States contained DDT. It was therefore necessary to face facts and choose one of two alternatives: ban cows' milk from interstate commerce, or set a tolerance.

The second alternative was chosen, and the tolerance set at 0.05 parts per million (ppm). This was a far lower level than the 7 ppm permitted for most agricultural products. A rule of thumb for tolerance levels is 1% of the toxic dose which is lethal to 50% of a group of experimental animals. Obviously, if 7 ppm had been estimated to be non-injurious, a tolerance of 0.05 ppm provided an unusually large margin of safety. The low tolerance was possible primarily because cows metabolize and break down DDT very effectively, and also because great attention was paid to avoiding the use of DDT on crops, such as alfalfa, which are consumed by dairy cattle. In contrast, human beings are less efficient than cows in metabolizing DDT, and they do not eat hay. There is a straight-line relationship between DDT intake and DDT level in body fat.[14] If the dosage decreases, the content of DDT in the fat becomes less. This is the result of an equilibrium level between intake, breakdown and excretion in the urine. A level of 10 ppm in the body fat is apparently harmless; far higher levels occur in spray operators and workers in DDT manufacturing and formulating factories who remain in good health despite prolonged exposure for periods up to 20 years.[15] Dr. J. M. Barnes (Director, Toxicology Research Unit, British Medical Research Council) summed up the matter as follows:

> Unfortunately, DDT is relatively slowly metabolised and excreted by the mammal and by virtue of its solubility characteristics tends to get laid down in tissue fat. Here it would have remained as an innocent and unrecognised passenger but for the fact that the chemists invented a sensitive chemical method, since further enhanced by the gas-liquid-chromatographic technique capable of detecting the chlorine and indicating its source even in minute quantities. Thus it has become possible to establish an anxiety neurosis in respect to a few parts per million of a compound in a tissue such as fat where a few parts per thousand in the whole animal are of no toxicological significance.[16]

A good example of one of the many studies on the prolonged effects of DDT on human subjects is the recent publication by Hayes and co-workers who reported that:

> Twenty-four volunteers ingested technical or p,p′-DDT at rates up to 35 mg. per man per day for 21.5 months. They were then observed for an additional 25.5 months, and 16 were followed up for five years. Storage of DDT and DDE and excretion of DDA were proportional to dosage. The fat of those receiving technical insecticide at the highest rate contained 105 to 619 ppm of DDT when feeding stopped. The average dosage of p,p′-DDT administered in this study was 555 times the average intake of all DDT-related compounds by 19-year-old men in the general population and 1,250 times their intake of p,p′-DDT. Since no definite clinical or laboratory evidence of injury by DDT was found in this study, these factors indicate a high degree of safety of DDT for the general population.[17]

DDE and DDA are two breakdown products of DDT. DDE is not insecticidal, but it has an effect similar to that of DDT in inducing the production of microsomal enzymes. DDA is an acetic acid derivative. It is inert, is soluble in water and is excreted in the urine.

The DDT in human beings enters the fat of breast milk. This was noted and published in 1950 by Laug and co-workers who found an average concentration of DDT of 0.13 ppm in 32 samples taken in Washington, D.C., with a range from undetectable ("zero") to 0.77 ppm.[18] Several similar reports have since appeared, and the results of an extensive survey were described by Quinby and co-workers.[19]

It may be concluded from the preceding discussion that the DDT level in human milk is about twice as high as the tolerance allowed for cows' milk by the FDA. That bald conclusion, however, requires explanation: it must be explained in terms of its underlying premises and toxicological implications. The use of the unqualified conclusion to create public alarm is a scientifically irresponsible act.

The DDT content of human milk has also been scrutinized by the World Health Organization and the Food and Agricultural Organization of the U.N. They set a permissible rate of intake of 0.01 mg. of DDT per kilo of body weight for breast-fed infants. The DDT intake of breast-fed babies in the United States may be higher than this; estimates range from 0.014 and 0.02 mg/kilo/day at birth, if the infant consumes 600 ml. (about 1⅓ pints) of breast milk daily. As the infant grows the intake of milk on a per-kilo basis decreases because food intake per unit of body weight lessens when the size of an animal increases. Furthermore, breast-fed infants usually receive supplementary feeding with other foods.

The "permissible rate" set by the WHO-FAO, according to the chairman of the meeting that established the value, is highly conservative, and he points out that

> it offers a safety factor of about 25 compared with what workers in a DDT manufacturing plant have tolerated for 19 years without any detectable clinical effect (see Laws *et al.*, *Arch. Environ. Health*, 15: 766–775, 1967). The safety factor of the WHO-FAO permissible rate is 150 compared to the dosage of DDT given daily for 6 months to a patient with congenital unconjugated jaundice without producing any side effects (Thompson *et al.*, *Lancet* 11, (7610): 2–6, July 5, 1969).
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> Infants are more susceptible than adults to some compounds, but the difference is seldom great—usually about 2 to 3 times. In a study of 49 different compounds, newborn rats were found to vary from 5 times less susceptible to 10 times more susceptible than adults. Although there is no information on the relative susceptibility of human infants and adults to DDT, it is shown by Lu *et al.* (*Food and Cosmetic Toxic.*, 3: 591–596, 1965) that weanling rats are slightly more resistant than adult rats to this compound, and that preweanling rats are more than twice as resistant and newborn rats are over 20 times more resistant than adults.[20]

Evidently it is possible for breast-fed infants to obtain DDT from the milk at a level up to twice the WHO-FAO "permissible rate." Again, background information indicates that no toxic effects have been detected or could be anticipated at this level. Nevertheless, the EDF and its collaborators have conspicuously proclaimed a warning that DDT may cause cancer. This adds to public apprehension, especially among nursing mothers. The question of carcinogenicity therefore should be discussed.

The "Delaney Clause" of the Food Additives Amendment[21] prohibits the use of any food additive that has been found to cause cancer in experimental animals. It is difficult to think of a more meritorious or public-spirited objective than is implied by this clause. It is even more difficult to *comply* with it, because all foods contain substances which can be shown to cause cancer in experimental animals, given the appropriate dose and the susceptible animal. All foods contain traces of radioactive elements which are present naturally. All meat products contain sterols and steroid hormones, which produce breast cancer in mice.

Pyrolysis—scorching—such as occurs in barbecuing of meat or the roasting of coffee, produces carcinogens and is only one of many examples of processes or substances in foods that can produce cancer in experimental animals when at high levels. The Delaney clause is usually regarded among scientists as being impossible either to administer or repeal. The Secretary's Commission on Pesticides, Department of Health, Education and Welfare made the following recommendation and comments:

> *Recommendation 8: Seek modification of the Delaney clause to permit the Secretary of the Department of Health, Education, and Welfare to determine when evidence of carcinogenesis justifies restrictive action concerning food containing analytically detectable traces of chemicals.*
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> The effect of the Delaney clause is to require the removal from interstate commerce of any food which contains analytically detectable amounts of a food additive shown to be capable of inducing cancer in experimental animals. This requirement would be excessively conservative if applied to foods containing unavoidable trace amounts of pesticides shown to be capable of inducing cancer in experimental animals when given in very high doses. If this clause were to be enforced for pesticide residues, it would outlaw most food of animal origin including all meat, all dairy products (milk, butter, ice cream, cheese, etc.), eggs, fowl, and fish. These foods presently contain and will continue to contain for years, traces of DDT despite any restrictions imposed on pesticides. Removal of these foods would present a far worse hazard to health than uncertain carcinogenic risk of these trace amounts.

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> Commonly consumed foodstuffs, contain detectable amounts of unavoidable naturally occurring constituents which under certain experimental conditions are capable of inducing cancer in experimental animals. Yet, at the usual low level of intake of these constituents, they are regarded as presenting an acceptable risk to human health.
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> Exquisitely sensitive modern analytical techniques which became available since enactment of the Delaney clause permit detection of extremely small traces of chemicals at levels which may be biologically insignificant. Positive response in carcinogenic testing has often been shown to be dose-related, in that the carcinogenic response increases with increasing dose levels of the carcinogen; when the dosage of a carcinogen is minimized, the risk for cancer is also minimized or eliminated. . . .
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> The recommendation for revision of the Delaney clause is made in order to permit determinations essential to the protection of human health, not to justify irresponsible increases in the exposure of the population to carcinogenic hazards.[22]

However, any attempt at such a revision would meet with great political opposition in the light of current fears and superstitions regarding "chemicals."

The above quotation speaks of the "uncertain carcinogenic risk" of trace amounts of pesticides. I shall review this statement with regard to DDT. The question of carcinogenicity of DDT was examined extensively starting in 1947. The above statement by the Commission was based on a recent report by Innes *et al.*[23] which is essentially a repetition of observations made about 20 years ago. The extensive earlier work on DDT and tumors in experimental animals includes about 20 articles in the scientific literature. In 1944, Lillie and Smith described hepatic alterations in rats kept on a diet containing 1000 ppm of DDT for 14 weeks.[24] Similar changes were observed repeatedly by subsequent investigators.

These findings aroused much interest and a number of toxicologists studied the effects of DDT in various experimental animals. Cameron and Burgess fed very high levels of DDT to rats, and produced liver damage that was severe enough to account for death in a number of the animals.[25] However, when the DDT was discontinued "the dead cells were removed by autolysis and phagocytic action and repair was complete without any fibrosis, although calcification was occasionally seen."[26] In plain language, if the rats were fed enough DDT to produce acute liver damage, and then the DDT was stopped, the animals got better. No cancer was found.

A more prolonged ordeal for rats, which were given a level of 100 ppm of DDT in the diet, was described by Fitzhugh and Nelson.[27] After two years, which is roughly equivalent to 70 years for a human being, a "minimal hepatocarcinogenic tendency" was noted by the authors. The authors could not decide whether the tumors were benign (adenomas) or low grade hepatic cell carcinomas.

These findings draw attention to an interesting matter known as the *dose-response curve*. It is possible to calculate the time of onset of symptoms from the daily dose of a toxic substance. If the dose is low enough, a calculation may show that the average animal will die of old age before it develops tumors. Since biological responses are subject to individual variability, the "average" animal does not represent all the animals in a group. There will be a few animals, perhaps only one in a million, that will develop tumors at a considerably lower dose than the average. This is the basis for suggesting so-called "mega-mouse" experiments (a million mice per experiment!) to detect borderline effects of mutagens and carcinogens. But in a million animals there are enough spontaneous tumors and mutations to make the results undecipherable at low levels of the chemical.

Fitzhugh and Nelson also described recovery experiments with rats on 1000 ppm of DDT for 12 weeks.[28] Extensive necrotic changes in the liver were produced during this period. The livers returned to normal after 8–10 weeks, indicating an absence of malignancy in the 12-week lesions. In these and various other studies with DDT, the minimum concentration in the diet was 100 ppm. At lower levels, the smallest detectable morphologic effect was at 5 ppm, reported by Laug *et al.*[29] These authors also reported hepatic cell changes in rabbits, mice and guinea pigs fed DDT, but the changes were not as marked as in rats. They were absent from chickens, dogs, cats, monkeys and large domestic animals. As a result, the liver changes are regarded by many pathologists as being characteristic of rodents. Various investigators have been unable to produce any pathology in rats fed DDT; indeed, the British investigators Cameron and Cheng concluded that the histological changes reported by others were "fixation artefacts."[30] These differences of opinion stimulated further research. This extensive series of publications and investigations was reviewed in 1965 by Arnold Lehman, chief of toxicology for the United States Food and Drug Administration, and his conclusion was that "DDT is not a carcinogen."[31]

The liver changes produced by DDT in rats and other rodents were described by Hayes as involving the cellular tissue that produces the "microsomal enzymes", as being reversible, and as being peculiar to rodents.[32] He also pointed out that the changes could also be produced by phenobarbital, by pyrethrum (a "natural" insecticide), by ethyl alcohol and by oxidized fats. The microsomal enzymes have various effects including the breakdown of some toxic substances and certain hormones.

The allegations by the EDF that DDT is a carcinogen are based primarily on three reports. The first is an article by Innes and co-workers with mice, which the authors call a "preliminary note."[33] Just why it was necessary to publish a "preliminary note" on a subject (the effect of DDT on rodents) that had been covered exhaustively over a period of ten years by a large number of experiments is not clear. The amount of DDT fed was the maximum tolerated dose, 140 ppm in the diet, and the experiment lasted 18 months, which is most of the lifetime of a mouse. The results were as follows:[34]

Supplement (and no.)	Level used		% Mice with tumors		
	mg/kg*	ppm	Hepatomas	Lung	Lymphoma
None (controls) (338)	—	—	4.1	6.2	4.1
p,p'-DDT (72)	46.4	140	31.9	5.5	10.9

* Dosage was oral for 7–28 days, then added to diet.

In confirmation of experiments reported earlier by other scientists, there was an eight-fold increase in hepatomas over the controls, and a borderline effect on lymphoma, to which mice are highly susceptible. Hepatomas are defined as tumors that are on the borderline between benign and malignant. Dr. Hayes commented as follows:

> Innes, *et al.* (1969) reported that the tumorigenicity of selected pesticides and industrial compounds was tested by continuous oral administration to both sexes of two hybrid strains of mice, starting at the age of 7 days. The chemicals were given by stomach tube until weaning and thereafter as a mixture in the diet. Maximal tolerated doses were given for the entire period of observation, about 18 months. The authors stressed that the dose received by the mice was far in excess of that likely to be consumed by humans. One of the compounds that gave a statistically significant positive result was DDT. The incidence of tumors was comparable to the mean tumor incidence

produced by a group of positive control compounds, most of which are weak or even questionable carcinogens of no demonstrated importance to human health. The authors made no distinction between hepatomas and carcinomas. It is difficult to understand why, in denying the practicality of making this important distinction, they entirely neglected the matter of reversibility. A full account of the study is promised later. In the meantime there is no assurance that the small number of tumors observed in mice exposed to DDT were different from the "nodules" described by Fitzhugh and Nelson in 1947.[35]

In this experiment, the mice received about 3000 times as much DDT in their diet as is consumed by people in the United States. It is primarily on this experiment that the allegations rest that DDT causes cancer. The other two reports are trivial; in one of them the diet of mice was suspected of being contaminated[36] and the second was based on a far-fetched inference which one of the authors (Deichmann) later "soft-pedaled."[37] The inference was that DDT was found in higher concentrations in fatty tissues of persons with terminal degenerative diseases than in fatty tissues from "normal" autopsy samples. However, such terminal diseases are usually accompanied by emaciation, which would concentrate the DDT in the remaining fat, and Deichmann, *et al.* have commented that the "investigators did not demonstrate a causal relationship between those diseases and pesticide retention in body tissues."[38] Yet a causal relationship is repeatedly emphasized by the lawyers for the EDF, the National Audubon Society and the Sierra Club.

The argument over DDT and cancer is important because millions of lives hang on it. If DDT were officially tabbed as a carcinogen in the United States, its use in the world-wide malaria control program would be severely inhibited or even stopped. What would this do? Ceylon has provided an excellent object-lesson:

> Following a country-wide malaria eradication campaign in the 1950's and early 1960's, the number of confirmed malaria cases reached lows of 31 in 1962 and 17 in 1963, when full-scale house spraying was partially withdrawn, and subsequently terminated in 1964. The cases increased annually thereafter, numbering 150 in 1964, 308 in 1965, 499 in 1966, and 3466 in 1967, most of them occurring in the last few months of that year. In 1968, the epidemic flared rapidly—16,493 confirmed cases being reported in January and 42,161 in February. No DDT supplies were on hand with which to reinstate the house

> spraying program on the wide scale needed, and months were required for the procurement and delivery of them. As a result, more than a million cases of malaria occurred throughout the country in 1968.[39]

What is the *real* effect of DDT on babies? Let us reverse the coin—What is the effect of malaria? Burnet had something to say on this. He wrote in 1953 that malaria

> is the great devitalizer of the tropics. . . and it is the main agent of infantile mortality. If malaria could be suddenly eliminated from the globe, the racial, economic and political consequences within a very few years would probably be appalling. India and parts of Africa are populated up to and beyond the capacity of the land to provide adequate food by present methods, and even with the tremendous infantile and prenatal mortality caused by malaria, the populations are increasing steadily. The sudden conversion to a more vigorous and rapidly increasing population would undoubtedly produce famine (emigration) and intense internal and external social repercussions.[40]

Nine years after Burnet's article, the effects of the anti-malaria program in India were described by Pal:

> The control programme [with DDT] was launched in April, 1953 and it was designed to give protection to 200 million people living in the malarious areas of the country. . . . Improved knowledge on malaria control led to the revision of the original strategy and the aim became the eradication of the disease for the entire sub-continent. In April, 1958, the National Malaria Eradication Programme was launched. It consists of three phases: attack, consolidation and maintenance. The attack phase is aimed at total interruption of transmission by spraying with residual insecticides all roofed structures throughout the country. . . . Since 1953, about 147,593,270 lb. of DDT have been used, with small amounts of BHC and dieldrin. As a result, malaria morbidity has been significantly reduced in the country. The proportional case rate of malaria (per cent of malaria cases to total diseases as clinically diagnosed) in each year of this programme has shown a decline. . . . Estimates of actual morbidity and mortality are difficult but it would appear, from the available data, that malaria in India has been reduced from 75 million cases to less than 5 million. A new era in economic development and social progress has been initiated with its beneficial transformation of the life of the people. The average span of life in India is now 47 years, whereas before the eradication campaign it was 32 years. This improvement has resulted in better agriculture and industrial production. In the Terai region (Uttar Pradesh), land under cultivation and food grain production

has increased and this region, once abandoned by its inhabitants because of the high incidence of malaria, has become a beautiful and prosperous area.[41]

WILDLIFE, NATURE STUDY AND INFERENCES

It is often difficult to obtain controlled and reliable results on the question of toxicity of chemicals to wildlife under field conditions. The temptation to blame pesticides indiscriminately for the death of wild creatures seems irresistible to organizations committed to the protection of wild animals. A trace of DDT reported in a dead bird or fish often triggers a chain reaction of publicity and incrimination. On the other side of the ideological fence, the farmers and entomologists give considerable weight to the fact that, in order to be able to eat and to protect themselves against major diseases, human beings must vigorously wage war on noxious insects. Chemical pesticides are essential in this fight. The release of pesticides into the environment, and the presence of traces of pesticides in our food, are inevitable if the human race is to maintain its present numbers and control of disease. It is obvious, or course, that the use of pesticides must be kept down to the minimum level commensurate with adequate crop production and disease control.

Modern agricultural technology as practiced in the United States is a development that has taken place largely in the past half-century, with major advances in the last 25 years. Geneticists, chemists and engineers have made great contributions to increasing the food supply and simultaneously lifting the burden of toil from farming. The easy availability of food has accelerated the movement of people to the cities.

Food is never pure. In the 1930's, contamination of food by pests was a major problem; for example, canned vegetables were spot-checked for pieces of insects. Today much testing is done for pesticide residues. With rare exceptions, the amounts found are well below the tolerances, which in themselves are far below the toxic levels. Pesticide residues in foods are not a public health problem. The absence of such residues could be brought about by stopping the use of pesticides. This would create a real problem—food shortages.

It would not be possible to reverse this movement and replace chemical technology by hand labor on farms without a great social dislocation. If chemical herbicides are not to be used, "the man with the hoe" must return to the farm and work long hours. In China, until recently, grasshoppers were killed by hand, but most of the major pest insects are too elusive for even this archaic procedure, and "biological control" can play only a minor part in keeping such insects from destroying crops.

Many of the charges that DDT destroys wildlife are based on inference. Often the charges have been based on tests that appeared to detect traces of DDT or other pesticides, and no consideration was given to the quantitative aspects of the results. Sometimes the effect of non-pesticide factors is disregarded or ignored. An example is the occurrence of large numbers of dead fish in the lower Mississippi River. This was blamed, with great fanfare, on pesticide contamination of the water. Subsequently the deaths were attributed to bacteria, *Aeromonas liquefaciens*, and to a lack of oxygen resulting from run-off of flooded fields.

The decline of the crab catch in the vicinity of San Francisco in 1969 was blamed on DDT. A scare article and banner headline appeared on the front page of the *San Francisco Chronicle* stating that the decline resulted from the toxic effects of DDT.[42] The story warned the public that crab meat might be contaminated. Strangely enough, the crab fishery further north on the California coast reported record catches for three seasons, and the most recent one was 14 million pounds (making one wonder whether the species will be "fished out"). In November, 1970, another San Francisco newspaper headlined: "What Happened to Our Crabs? Pollution!"[43] The article stated:

> The dumping of millions of gallons of highly poisonous wastes off the Farallones is probably responsible for the drastic slump in the San Francisco crab fishery.
>
> State Fish and Game Biologists Don Lollock and John Ladd in a report to the Regional Water Quality Control Board said that although absolute proof is lacking, evidence of the decline points to the oceanic pollution.
>
> The catch has dropped from a high of nearly nine million pounds in the 1956–57 season to 1.4 million last season.
>
> The biologists recommended the board take prompt action to stop such industrial waste discharging.
>
> On receiving the State Fish and Game Department document, the board yesterday took emergency procedures to place the subject on the agenda for action at its Dec. 22 San Francisco meeting.
>
> Three firms use the ocean for major dumping. U. S. Steel, given a Dec. 15 deadline yesterday for improving the quality of discharges

> from its Pittsburg works, dumps in the neighborhood of 15 million gallons of acid steel waste containing sulphuric and hydrochloric acid annually.
>
> Sulfates and large concentrations of heavy metals also are barged and unloaded in the Farallones Gulf, nine miles from the City.[44]

What happened to our crabs? What happened to the DDT that was blamed in 1969?

DDT was found in the livers of dead sea lions on the coast of California in the late summer of 1970, and, as usual, the newspapers swung into action to condemn the insecticide. In November, a memorandum was issued by Dr. Richard Hubbard of the Marine Mammal Study Center, Fremont, California, describing the findings of a team that had diagnosed the deaths as being due to leptospirosis. The diagnosis was based on symptomatology, post-mortem findings, identification of *Leptospira pomona*, blood antigen tests and epidemiology. He commented that "there is no correlation between mercury and DDT levels, and sick animals." But, by November, who was interested? Certainly not the EDF. *Leptospira* is "part of the environment."

Robinson Jeffers has written, "Give your heart to the hawk." The bird protection societies would seemingly have us follow this admonition and, indeed, the speed and audacity of the bird of prey appeal to the Walter Mitty who lurks in most of us. Eagles have many admirers, while chickens (at least, while alive) have but few. The dire warnings that bald eagles were threatened by DDT were enough to arouse horror against this insidious chemical. For example, a photograph on the cover of *Science*[45] showed a bald eagle's nest with one unhatched egg and one apparently healthy eaglet. The failure of one of the eggs to hatch was attributed to the presence of DDT in fish in the Great Lakes area. But is the story true?

An examination of scientific literature which antedates the extensive use of DDT is instructive. It reveals that even in such earlier years the survival of the eagle was deemed a critical issue. For example, in 1921 an article entitled "Threatened Extinction of the Bald Eagle" appeared in *Ecology*. In 1943, F. Thone stated in *Science News Letter*: "When the timber was cleared, it was inevitable that the eagles had to go. Moreover, the cities grew and befouled the rivers with sewage and industrial wastes. The once teeming fish population vanished."

The Territory of Alaska paid a bounty of 25 cents per claw for 115,000 bald eagles assassinated between 1917 and 1952. There are now an estimated 7000 bald eagles in Alaska, about 6% of the number that was slaughtered. Gunfire continues to be the main cause of death of bald eagles, according to United States Department of Interior figures: of 76 dead specimens examined between 1960 and 1965, 44 were shot, 7 died of impact injuries, 3 of other violent forms of death, 4 of disease or old age, and the remaining 18 of undetermined causes. More recently, the same Department has reported "poisoning from dieldrin in growing numbers of bald eagles found dead in the United States"[46] and also that mercury poisoning has been detected in bald eagles.[47] The last finding draws attention to the presence of potentially toxic levels of mercury in fish in the Great Lakes, and suggests that mercury may be the cause of reproductive failure in the bald eagles in this region.

Why was DDT blamed? As George Mallory said of a certain mountain, "Because it was there."

How are the eagles doing? According to the National Park Service, a record number of 373 bald eagles, 120 of which were immature, were counted on November 20, 1969, below Lake Macdonald in Glacier National Park and 268 (with the birds still flying in) on November 25, 1970. The percent of immatures has held "a steady 31" during the past five years. This meant, according to the Park Service, that the birds came from "areas not yet seriously affected by pesticides," an explanation which is on a logical par with stating that the birds are alive because they are not dead. Evidently pesticide poisoning plays no more than a minor role in the demise of bald eagles. The alleged effects of DDT are now being second-guessed in favor of other chemicals.

In Scotland, the use of dieldrin in sheep dips was concluded to be the cause of a decline in the breeding ability of the golden eagle, which eats sheep carrion. This use of dieldrin was discontinued in 1966, following which there was an improvement in breeding success in golden eagles.[48]

The story of the peregrine falcon is similar in many respects to that of the eagle, except that the peregrine is even rarer. It is not only the object of man's hostility because it eats racing pigeons, but it is also harassed by the robbing of its eyries to provide young birds for falconry, and eggs for collectors. The peregrine falcon is considered as no longer breeding in the eastern United States. However, the counts of migrant peregrines at Hawk Mountain, Pennsylvania, were as follows:

1935–1942	ave.	32
1967		22
1968		21
1969		26
1970		27

It is obvious that the peregrine was rare even prior to 1940; the total annual count of hawks at Hawk Mountain ranges between 10,000 and 20,000.

The rapid decline of the peregrine in the eastern United States took place prior to the introduction of organic pesticides,[49] and seems to have been caused by harassment.[50] The peregrine population in the eastern United States is estimated as having been something less than 275 breeding pairs in 1940. In contrast, the peregrine population in Northern Canada and Alaska is reported to be thriving and was estimated by Fyfe (1969) as about 7,500 breeding pairs.[51]

Whether or not counts like those above can be read as linking DDT with animal deaths, the counts must be kept in proper perspective. All such statistics should be reviewed in the context of other "human" statistics. One cannot ignore, for example, that before the advent of DDT, 2000 *people* per *day* were dying in India from malaria.

Other analyses have been made of the effects of DDT on the peregrine. High levels of DDT and its metabolites were reported in the fat of peregrine falcons in the Yukon[52] but a "seemingly normal average" of viable eggs and young was found in 15 nests in this region. Fat biopsy samples from nine females had an average content of 37 ppm DDT, 284 ppm DDE and 40 ppm TDE (DDD). The samples also contained an average of 3.3 ppm dieldrin and 4.4 ppm heptachlor epoxide. During this survey, the nests were robbed to obtain eggs for analysis, and female falcons were trapped and slit open to take samples of body fat. Following this, the unfortunate birds were sutured and released, after which they "showed normal behavior." One wonders how long they survived. The authors noted that the eggs were taken from eyries where reproduction was normal and averaged about 27 ppm of total organochlorine residues. Ratcliffe stated that the residues in eggs from unsuccessful eyries were 17.4 ppm; these were to be compared with the residues of 12.7 ppm in eggs from successful eyries in Great Britain.[53] The disparity between the two sets of findings suggests that the reason for reproductive failure in the peregrine has not been identified.

The British Advisory Committee on Pesticides and other Toxic Chemicals, in a comprehensive review on organochlorine pesticides published in 1969, stated:

> There is no close correlation between the declines in populations in predatory birds, particularly in the peregrine falcon and the sparrowhawk, . . . and the use of DDT. Therefore DDT does not appear to have been the principal cause.[54]

In summary, the peregrine as a breeding species in the eastern United States appears to have been extirpated primarily by harassment, and no role for DDT has been shown. The peregrines in northern Canada are breeding successfully despite high tissue levels of organochlorine pesticides. The current reduction in the use of these pesticides should tend to a lowering of these levels, and the future of peregrines in this region does not appear to be in jeopardy.

The osprey, or fish hawk, was a conspicuous species along the eastern seaboard of the United States, even in populated areas such as Gibson Island on Chesapeake Bay. A decline in the population of ospreys in such areas has been attributed to DDT. Harassment seems more likely to be the major cause, because the osprey is evidently increasing in the eastern United States and Canada. An obvious explanation is that the birds have moved away from the region of suburban developers and outboard motors in search of peace and quiet. The osprey count at Hawk Mountain averaged 172 per year from 1935 to 1942, pre-DDT years. Recent counts are:

1965	444
1966	405
1967	467
1968	403
1969	530
1970	600 (a record high)

The counts at Hawk Mountain must be interpreted with care, because up until about 10 years ago there was only one look-out, and now there are three, at least two of which "are manned every day, all day, from mid-August through November," according to Dr. J. W. Taylor, who estimates that 20 years ago, under today's conditions, the "number of hawks seen would have been at least three times, and probably five or six times, what our figures in 1969 show." Dr. Taylor nevertheless states that "the

Osprey population on the interior lakes has greatly increased, and these are the birds we are now seeing at Hawk Mountain."

Naturally all of us hope that hawks and eagles will survive the onslaughts of human interference. However, blaming DDT seems a convenient excuse. If a species is still being counted at Hawk Mountain, it is obviously *not* extinct, and if the numbers have not decreased greatly in recent years an interpretation that the species is drastically declining is questionable in the absence of further study.

DDT and Photosynthesis in the Ocean

DDT is said to be steadily accumulating in the seas by distillation from the surface of the land, by drainage into rivers and by the blowing of dust. It is also alleged that DDT is, in effect, indestructible, because its principal metabolite, DDE, resembles DDT in inducing the production of microsomal liver enzymes. One of the most sensational anecdotes about DDT is the prediction that it will stop photosynthesis in the oceans, as a result of which life on Earth will become extinct. This story was repeated by diverse authorities ranging from U Thant to Ehrlich, who stated[55] that it originated in Wurster's report.[56] This report described the effects of adding graded amounts of an alcoholic solution of DDT to algal cultures in sea water and measuring photosynthesis by carbon-14 uptake. The DDT was added to produce concentrations up to 500 ppb. Not surprisingly, photosynthetic uptake of carbon-14 was depressed at the higher levels, since DDT is phytotoxic above certain levels. Its maximum solubility in sea water is 1.2 ppb, and DDT would be precipitated and adsorb to the algae above this level. The results as presented by Wurster show that at the points corresponding to 1 and 2 ppb, there was no depression of carbon-14 uptake.

The findings at these levels were as follows:[57]

Species	Effect of DDT on C^{14} Uptake*	
	1 ppb	2 ppb
Skeletonema costatum	−	−
Coccolithus huxleyi	+	+
Pyramimonas sp.	−	+
Peridinium trochoideum	+	+
Mixed culture**	+	+

* Increases over controls, +; decreases −.

** Typical neritic phytoplankton community.

According to these fragmentary findings, a saturated solution of DDT in sea water would not depress photosynthesis. Wurster states:

> The fact that these data apparently follow sigmoid curves is typical of dose-response relations and suggests the absence of a threshold concentration of DDT below which no effects occur. Experimental scatter produced some uptake of C^{14} above 100 percent at low concentrations of DDT, however. This should not be interpreted as a low-level stimulatory effect, a possibility that cannot be evaluated from these data.[58]

Obviously if the data show an indication, even slight, of a low-level stimulatory effect, it follows that the same data cannot be used to postulate a "no threshold" situation. Wurster pointed out that "water near a direct application of DDT to the environment, however, commonly contains concentrations comparable to those applied by me."[59] This is a far cry from stopping photosynthesis in the oceans as suggested by Ehrlich. Wurster goes on to state that "selective toxic stress by DDT on certain algae" may "favor species normally suppressed by others, producing population explosions. . . . Such effects are insidious."[60] (The word "insidious" is a favorite word in the lexicography of DDT.) Increases and decreases in aquatic photosynthesis can both be blamed on DDT. It is a well-documented observation that over-application of DDT to green crop plants may cause not only depression of photosynthesis, but death. Over-application of various chemicals kills plants; common salt, for example, used to be used as a weed-killer.

To produce a concentration of 1 ppb of DDT in the 300 million cubic miles of sea water in the oceans would take 9,000 years if the total annual production of DDT, 300 million pounds, were dispersed in the oceans each year and there was no breakdown. If the half-life of DDT in sea water is one thousand years or less, this concentration would never be reached.

The absurdity of these figures illustrates the need for quantitative examination of allegations, but is not intended as a suggestion that it is safe or desirable to use the ocean as a sink for pollutants.

CONCLUSION

This article has treated only a few of the points that demonstrate DDT's ultimate safety and significant contributions to

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man. I have chosen to discuss these few points at length, rather than to mention a large number of topics briefly. A final response, however, must be made to the charge that DDT has injurious effects on human beings. The particular charge to which I respond is based on the observation that DDT inhibits certain enzymes in laboratory experiments. Contrary to what DDT opponents would have us believe, a similar observation can be made of any of a number of substances. For example, many of the substances that we eat—salt, phosphate, magnesium, citric acid—drastically affect enzymes in test tube experiments. These experiments, moreover, do not involve intact animals. By contrast, the everyday use of DDT does involve intact animals, and the effects are remarkably minimal. In point of fact, *several hundred million people* have been exposed to DDT for prolonged periods of time without any sign of ill effect. Some of them have received heavy doses, over periods at up to 19 years[61]—the 130,000 spraymen listed by the WHO, for example, and numerous people in DDT factories and formulating plants—all without any reports of illnesses attributable to DDT. In the 1940's, enthusiastic volunteers allowed themselves to be used as experimental animals and swallowed large amounts of DDT, in some cases daily for prolonged periods.[62] For some reason, nothing seemed to happen except transient tingling of the extremities. Some day the true story of DDT, buried in the scientific literature, will be brought out into the open.

We may certainly expect an increase in dialogue between scientists and lawyers as the number of legal questions involving the environment grows apace. Such dialogue, however, when it occurs in the tightly structured setting of the courtroom, may have unfortunate consequences. If a scientist is asked, for example, whether a pesticide is poisonous, he will say "Yes;" at the same time, however, he may recommend its use at an appropriate level as a proper response to human needs. A skillful attorney can effectively exploit such an apparent contradiction, following which the scientist will probably withdraw into his shell. In the 1969 Wisconsin hearings on DDT, such incidents repeatedly took place during examinations by Environmental Defense Fund (EDF) attorney, Victor J. Yannacone, Jr. An EDF spokesman, C. F. Wurster, expressed much satisfaction with Mr. Yannacone's efforts:

> Victor J. Yannacone, Jr., the Environmental Defense Fund's at-

> torney, has an impressive grasp of scientific material, especially the environmental sciences. His cross-examination is usually aggressive and may be devastating where a witness is scientifically weak.[63]

Wurster, however, later altered his opinion. On March 9, 1971, he stated:

> It has come to my attention that certain remarks, attributed to me by Mr. Victor J. Yannacone, Jr. in May 1970, have been inserted into the record of your hearings on pesticides during the testimony of Edward Lee Rogers of the Environmental Defense Fund.
>
> I wish to deny all of the statements of Mr. Yannacone. His remarks about me, attributable to me, and about other trustees of EDF are purely fantasy and bear no resemblance to the truth. It was in part because Mr. Yannacone lost touch with reality that he was dismissed by EDF, and his remarks of May 1970 indicate that his inability to separate fact from fiction has accelerated.[64]

Yannacone's fiery and uncompromising onslaught on DDT in Wisconsin was evidently undertaken for the purposes of advocacy, for on September 27, 1970, he said, in comparatively moderate tones:

> Any law simplistically banning the use, sale, manufacture or distribution of DDT in your state, county, city or even the United States, without at the same time establishing an ecologically sophisticated pesticide regulation program, is a bad law. It won't satisfy anyone very long and will permanently polarize agriculture and conservation to such an extent that common problems can no longer be considered in rational discourse.[65]

These remarks by Mr. Yannacone reflect a scientific sophistication that he did not reveal during the Wisconsin hearings. Regrettably, however, the earlier remarks seem to have gained greater attention.

This anecdote serves to illustrate an essential difference between the advocate and the scientist. The advocate seeks a prompt and unequivocal decision on a particular issue. The scientist, however, simply cannot expect such results; he thus strives to obtain facts which enable him to ascend the spiral staircase of knowledge. With each step of his ascent, he obtains a wider and superior view of his subject matter, and, although he never reaches the top, he should on his way up help his fellow men by telling them what he sees.

◆

Footnotes

[◆] Professor of Medical Physics, University of California, Berkeley.

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Birds on the Rise

By Philip H. Marvin

Consulting Entomologist, Manhattan, Kansas

Bird populations are increasing. Far from declining during the past 15 years of expanded insecticide use, bird numbers have multiplied severalfold. Entomologists have indicated an interest in figures supporting these statements, hence the statistics and the method of ascertaining the pertinent data are presented in this paper.

Bird watchers all over North America assemble each year in local groups within a week or so of Christmas. Bird-count data are assembled from these field observations and then recorded in *Audubon Field Notes*, a publication of the National Audubon Society, co-sponsored by the U. S. Fish and Wildlife Service. This census is known as The Christmas Bird Count. Arthur A. Allen (1930, p. 395), past ornithologist at Cornell University, wrote, "The Christmas Bird Census, for several reasons, produces records of greater accuracy and, therefore, of greater scientific value than similar records made at other times of the year." Allan D. Cruickshank, editor of Christmas Bird Counts, described *Audubon Field Notes* as "a quick, accurate source of information on population trends." (From letter, seeking subscriptions, dated August 28, 1963.) He (Cruickshank 1956) also described the Christmas Bird Counts as "probably the largest organized bird watching activity in the entire world."

Many variables affect the bird counts from year to year. Among these are unpredictable weather, since the local groups set their dates in advance, and of equal importance, the number of participants and their differing individual abilities and experience. Some of these variables are compensated for by the application of rules drawn up by the National Audubon Society. Two principal directives are the territorial limitations set for each group, and the time factor involved in the counts. Each group must stay within an area of 7½ miles from a central point and counting must be done during at least 4 daylight hours. Bird watching has grown considerably in popularity. By 1963 over 10,000 people were participating in the Christmas Bird Count, [illegible] as many as 15 years ago. Although the extent to which the newer members are able to contribute [illegible] application of the rules is unquestionably [illegible] arriving at reasonably accurate estimates. Increased number participation results in subdivision of groups or formation of entirely new groups, making possible an increase in thoroughness of coverage of each present area. Increased interest can result in discovering new birding spots. These effects are applicable largely to the less common species.

Common [illegible] varieties can be seen by a few observers as readily as by large numbers. Concentrations, such as [illegible] Canada geese on open [illegible], can be estimated as easily by one person as by several. While the count of large flocks of robins or blackbirds can be [illegible] several observers, [illegible] the estimate [illegible] reliable is submitted [illegible] the records [illegible].

Other surveys of birds are made by several agencies. For the most part they consider specific types or groups of birds, primarily game birds and waterfowl.

Audubon Field Notes record several types of bird surveys, including migration records and breeding records which are accumulated by many bird observers. As previously stated, the Christmas Bird Counts are considered to be the most accurate and reliable source of information on bird population trends. The data presented in the following tables were gleaned from issues of *Audubon Field Notes* 1949-63. Average (mean) counts involving 4 years are given as a means of reducing annual variations.

Table 1.—Average annual number of birds of all species counted and average annual number of people participating, plus the average number of birds counted per person.

Years	Birds	Observers	Birds per observer
1949-52	8,6[illegible]251	5,160[1]	1,6[illegible]7
1954-57[2]	23,14[illegible]380	6,603	3,505
19[illegible]-61	34,2[illegible]	8,511	4,024
19[illegible]2	44,6[illegible]7	9,981	4,471

[1] The number of observers for 1952 was not summarized in *Audubon Field Notes*. Based on the number for preceding and succeeding years, it was estimated at 6,000 for this table.

[2] Data for [illegible] were not summarized in *Audubon Field Notes*, and are not included here.

These figures show a 5-fold increase in total bird numbers observed during the past decade, occurring despite the greatly increased use of "new" pesticides. Some of the apparent increase may be attributed to the greater number of observers but at least a 3-fold increase in bird populations can be considered as a reasonably reliable estimate.

Robins have been used as an illustration of the detrimental effects of pesticides on birds. The statement was made in a recent widely circulated book that robins [illegible] on the verge of extinction. Figures from *Audubon Field Notes* do not support this statement.

Table 2.—Average number of robins counted annually.

Years	Robins
[illegible]	41,214
[illegible]	86,386
[illegible]	367,733
[illegible]	928,095

With this [illegible] of robin populations, robins found dead from [illegible] causes should be in the proportion of [illegible] 20 to 1 [illegible] with [illegible] in a similar [illegible] to robins but [illegible]

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control as compared to the amounts used in far more numerous orchards where several applications were made annually. Robin populations have exhibited a meteoric rise to accompany the expanded use of DDT, despite the contention of some that city tree-spraying programs were decreasing these birds.

Other urban shade-tree bird populations also have increased during the stepped-up spraying for control of Dutch elm disease, gypsy moth, leafhopper vectors of phloem necrosis, the elm leaf beetle and many other insect pests as shown in Table 3.

Table 3.—Average number of mourning doves, flickers and starlings counted annually.

Years	Mourning Dove	Flicker[1]	Starling
1949-52	13,131	4,278	717,477
1953-56	32,752[2]	[illegible]	1,561,710
1957-60	59,886	7,500	5,799,820
1961-62	65,860	9,216	8,119,410

[1] Yellow-shafted flicker.
[2] Data for 1955 were not summarized in *Audubon Field Notes* and are not included here.

Populations of several dooryard birds also showed increases since 1949, including the brightly colored cardinal and the melodious mockingbird, both associated with the South and its Imported Fire Ant Control Project:

Table 4.—Average number of cardinals and mockingbirds counted annually.

Years	Cardinal	Mockingbird
1949-52	19,576	4,430
1953-56	31,375	9,862[1]
1957-60	[illegible]	14,027
1961-62	61,942	15,176

[1] Data for 1955 were not summarized in *Audubon Field Notes* and are not included here.

Birds associated with agriculture also increased in populations despite the treating of farm buildings for flies, of cultivated fields for cutworms and corn borers, of alfalfa and pastures for weevils and spittlebugs, and of marshes and rice fields for mosquitoes.

Table 5.—Average number of house (English) sparrows, common crows, eastern meadowlarks and red-wing blackbirds counted annually.

Years	House Sparrow	Crow	Eastern Meadowlark	Red-wing Blackbird
1949-52	134,878	122,259	[illegible]	2,858,267
1953-56	239,073	[illegible]	[illegible]	[illegible]
1957-60	314,397	[illegible]	32,713	[illegible]
1961-62	[illegible]	233,524	[illegible]	11,812,660

[1] Data for 1955 were not summarized in *Audubon Field Notes* and are not included here.

The data in the foregoing tables show the recent explosion in bird populations, including many species associated with areas of frequent pesticide applications. Actual loss of birds to insecticides has been very minor. Most aids to civilization have adversely affected individual birds—automobiles, television towers (one in Wisconsin killed an estimated 15,000 in a single night (Kemper 1964), roads (wet pavements kill ducks mistaking them for ponds at night), and so forth. As can be seen from these data, the stories of bird populations affected by insecticides have been grossly exaggerated. As entomologists, we must keep these matters in correct perspective.

Entomological research, in fact all scientific endeavors, suffers when men are swayed by unfounded scare stories. The Secretary of Agriculture, Orville Freeman, when he spoke to the Weed Society of America in Chicago in February 1964, said Federal entomological research would concentrate on biological control; the chemical control investigations would be concerned principally with safer methods of application. Potential side effects of pest control are important and studies should be based on clear reasoning and reasonable probabilities. Entomologists fail the public, both the producing agriculturalist and the consumer, when their thinking and planning are shrouded by mistaken beliefs which obtain the status of fact only through repetition of scant and partial evidence.

A word of warning for the future: the present high populations of birds will make sudden decimations of certain species appear catastrophic. And such can well occur for many reasons. Some ornithological zealots have blamed the use of pesticides, primarily the Imported Fire Ant Control Program, for a sharp decrease in eastern bluebird numbers. However, Douglas James (1962), an ornithologist of Arkansas, pointed to the disappearance of bluebird populations that were never within the area of this program. His premise states: "This suggests that the fire ant program was not a major factor in causing the general decrease in bluebirds, leaving severe weather as a primary known factor." He cannot bring himself to let pesticides off the hook entirely, for he adds, "Private use of insecticides might affect bluebird populations outside the Gulf States but data are not available to evaluate the extensiveness of the factor."

Bluebird populations declined many years before the general use of pesticides. Edward Forbush (1929, p. 419) describes two great bluebird population catastrophes within his remembrance. The first was in the early 1870's, when English (house) sparrows drove the bluebirds from their nesting places. Then, "in 1895 cold and storms overwhelmed the Bluebirds in the south and almost wiped them out and for two or three years very few were seen in New England." He added, "Now they are harassed by the spread of the European Starling and many an old orchard where hollow limbs formerly sheltered families of Bluebirds is now tenanted by the usurping foreigner." Coinciding with the latest bluebird decline is the rise of [illegible] million to 8 million starlings.

[illegible] factors, natural and man made, will continue to [illegible] populations. Both Forbush and James mention storms and severe temperatures. From September to November 1957 more than 15,000 birds died in a [illegible] of ceilometer accidents and collision disasters (Overman 1958). Forbush cited the effects on populations of the displacement by house sparrows and starlings. James noted the possibility of harm from insecticides. If enormous declines of bird species do

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occur eventually, entomologists may then be compelled to take the initiative and have all possible causes investigated with equal thoroughness. The value of their work is at stake. The science of entomology must be free from erroneous conclusions if entomologists are to produce effective diagnoses.

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INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Notice of proposed use of Plenary Powers in certain cases

(A. (n.s.) 63)

In accordance with a decision of the 13th International Congress of Zoology, 1948, public notice is hereby given of the possible use by the International Commission on Zoological Nomenclature of its plenary powers in connection with the following cases, full details of which will be found in BULLETIN OF ZOOLOGICAL NOMENCLATURE Vol. 21, Part 2 published on April 23, 1964.

(1) Suppression of six specific names of mites (Acarina). Z.N.(S.) 1564;

(7) Validation of the specific name *Griselda radicana* Heinrich, 1923 (Insecta, Lepidoptera). Z.N.(S.) 1612;

(8) Designation of a type-species for *Baetis* Leach, 1815] (Insecta, Ephemeroptera). Z.N.(S.) 1620;

(9) Designation of a type-species for *Megalopta* Smith, 1853 (Insecta, Hymenoptera). Z.N.(S.) 1624;

(10) Suppression of *Amaurobius* C. L. Koch, 1836, and *Castor* Blackwall, 1840 (Araneae). Z.N.(S.) 1625;

(11) Validation of the family-group name PLATYPLEURINAE Schmidt, 1918 (Insecta, Hemiptera). Z.N.(S) 1626.

Any zoologist who wishes to comment on any of the above cases should do so in writing, and in duplicate, as soon as possible, and in any case before October 23, 1964. Each comment should bear the reference number of the case in question. Comments received early enough will be published in the BULLETIN OF ZOOLOGICAL NOMENCLATURE. Those received too late for publication will, if received before October 23, 1964, be brought to the attention of the Commission at the time of commencement of voting.

All communications on the above subject should be addressed as follows:

The Secretary,
International Commission on Zoological Nomenclature,
c/o British Museum (Natural History),
Cromwell Road,
London, S.W.7,
England

April 1964 W. E. CHINA, *Acting Secretary*

KANSAS ENTOMOLOGICAL SOCIETY

The [illegible] annual meeting of the Kansas Entomological Society [illegible] Central States Entomological Societies [illegible] at the University of Arkansas on May 2, 1964. [illegible] a social hour and business session. John Moser, [illegible] Forest Service, Alexandria, Louisiana, presented an invitational paper, "The biology, ecology and behavior of the town ant, *Atta texana*," illustrated by a movie and slides. Twelve papers were presented during the afternoon session. At the final business meeting the following officers were elected: President, R. J. Elzinga, Kansas State University; Vice-President, D. E. Howell, Oklahoma State University; Secretary-Treasurer, Carl W. Rettenmeyer, Kansas State University; Editor, Mrs. Mary H. Michener, University of Kansas. The next annual meeting will be held in Manhattan, Kansas on May 8, 1965, the day following the meeting of the Kansas Academy of Science. The Kansas Entomological Society is an Affiliate of the Entomological Society of America.

SNODGRASS REPRINT COLLECTION

The Robert E. Snodgrass library of reprints on insect anatomy and morphology is now housed in the U. S. National Museum, Department of Entomology, and is being perpetuated as a memorial to Dr. Snodgrass. Contributors to the field of insect morphology are invited to send copies of their papers, to be included in the library, to the Snodgrass Reprint Collection, Department of Entomology, U. S. National Museum, Washington, D. C.

FROM THE MANAGING EDITOR

Standard Periodical Title Abbreviations.—The ESA has joined many other organizations in adopting the "American Standard for Periodical Abbreviations" for use in listing references cited in the Society's publications. This ASA Standard was prepared by a Subcommittee of Sectional Committee Z-39 on Standardization in the Field of Library Work and Documentation. It will be followed by both *Biological Abstracts* and *Chemical Abstracts*. The complete list was published in *Biological Abstracts* 45 (13): July 1, 1964. An abbreviated list is included in the second edition (1964) of the *Style Manual for Biological Journals*, prepared by the Committee on Form and Style, Conference of Biological Editors. The "Style Manual," which is followed closely by ESA editors, is available from the AIBS, 2000 P Street, N. W., Washington, D. C., 20036. The price is $3.00 per copy. Contributors of papers for the Society's publications are urged to follow this "Standard" in preparing the References Cited section of papers.

Cover Photographs.—Beginning with the 1965 volumes, both the BULLETIN and the ANNALS will feature photographs of entomological interest on the covers of each issue. [illegible] may pertain to articles appearing in that issue or may be unrelated to the contents of [illegible]. Members are invited to submit photographs [illegible] the covers. Such photographs must be [illegible] accompanied by [illegible] technical data [illegible] photographer. No charge will be made for [illegible] selected for publication.

OPEN LETTER

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BIRD REPRODUCTION AND ABUNDANCE

by

SPONSORS OF SCIENCE

Dr. J. Gordon Edwards, President
(San Jose State College)

Early in the DDT controversy we were confronted with so many allegations that it was difficult to respond to them all in the available time. As the months passed, hundreds of scientists patiently refuted the allegations and publicized the data relating to each of the anti-DDT charges. The news media became aware of the fact that they, too, had been badly misled and in the past six months many reporters and editors have reversed their positions on DDT. Most anti-DDT charges have now been exposed as untruthful. It is now generally known by scientists that DDT does not cause tumors, cancer, hepatitis, heart disease, poliomyelitis, or other illness, does not continue to accumulate in animal tissues, does not inhibit photosynthesis in the marine environment, does not persist for decades in the environment, does not kill off populations of fish, crabs, oysters, birds, or mammals, and does not routinely "build up" in food chains. The only anti-DDT allegation still believed by many sincere persons is that it causes thin eggshells and thus may cause declines of bird populations. The facts belie that charge, as indicated in the following paragraphs.

ABUNDANCE OF BIRDS

Frequent attempts have been made to link bird declines with the widespread usage of DDT during the period between 1946 and 1960 (or with the greatly diminished usage of DDT during the following decade). When the allegations are investigated by study of the scientific literature and the popular press releases it becomes evident that the declines of birds either occurred before DDT was used, or occurred after the widespread usage had ceased, or occurred as though correlated with some other environmental cause. The great peregrine falcon decline occurred long before 1945; the bald eagle was "threatened with extinction" according to a 1921 article in Ecology; the White-tailed Kite experienced a tremendous population explosion during the years of heaviest DDT usage in its native California range; the Texas Brown Pelicans declined from a high of 5,000 birds in 1918 to a low of 200 or 300 in 1941 (including an 81% decline prior to 1935); the California Brown Pelican experienced NO recorded decline during all the years of heavy DDT use, but suddenly underwent a 99% collapse in production of young ten years later...just two months after the greatest recorded oil spill had surrounded their breeding island of Anacapa; the Florida Brown Pelican did NOT experience a decline at the same time the California birds did... even though Florida was using five times as much DDT as was California! The peregrine falcons in northern Canada were "reproducing normally", according to Enderson & Berger (1969), even with 30 times as much DDT, DDD, and DDE as was in the U. S. birds which were in reproductive trouble... and much more than in the "stricken British population". (The British population decline had already been attributed to dieldrin by the 3-year government study called the "Wilson Report", and the decline had ended in 1966, unbeknownst to many American ornithologists.) THIS TOTAL LACK OF CORRELATION BETWEEN DDT AND BIRD POPULATION DECLINES OR EXPLOSIONS IS SIGNIFICANT!

Plaintiffs Exhibit 26

In addition to the general lack of specific correlations between DDT and bird declines, we are impressed by the abundant evidence of population explosions of many kinds of birds, which ARE correlated with DDT use and with the concomitant use of various other chemicals and developments. A few of these data should be noted:

Dr. Wurster himself has commented on the abundance of birds during the DDT years, referring to "increasing numbers of pheasants, quail, doves, turkeys, and other game species", but adding that "These are all herbivores" and that "Herbivores do not become heavily contaminated" (with DDT, etc.). (From Congressional Record, 5 May 1969, page S4599). He also stated: "some birds of prey that feed on herbivores; i.e. red-tailed hawks, white-tailed kites and golden eagles, are also not involved, for the same reason. Birds at the ends of long foodchains are the ones in danger." (Same source). Because Dr. Wurster and his associates frequently mention fish-eating birds as being highly exposed to DDT and DDE, hence in greatest danger, the figures on fish-eating birds deserve special study. In Animals Magazine, April 1971, page 555, the numbers of gannets and murres are discussed. These fish-eaters have been doing very well! Gannets on Funk Island alone increased from 200 pairs in 1945 to 2,000 pairs in 1958 and 3,000 pairs in 1970. Murres were meanwhile increasing their population from 15,000 pairs in 1945 (the beginning of DDT usage) to 150,000 pairs in 1956, to 500,000 pairs in 1959, and to 1,500,000 pairs in 1971. The fish diet evidently did not affect them badly.

To Wurster's list of increasing bird populations, the Audubon Society has added the following: eagles, gulls, ravens, herons, egrets, swallows, robins, grackles, redwinged blackbirds, cowbirds, and starlings. (From Audubon Christmas Bird Counts between 1941 and 1960.) Overall, the Audubon counts show 26 species of birds have increased from 90.8 birds seen per observer in 1941 to 971.4 birds seen per observer in 1960.

Each year since DDT use began we have seen numbers of ducks and geese increasing at a remarkable rate. Other factors have contributed,but IF DDT were adversely affecting the birds as charged by Dr. Wurster's Environmental Defense Fund it would have been difficult for the ducks and geese to increase at all. In Union Co., Illinois, for example, there were 30,000 Canada Geese in 1954-55, but the number increased to 100,000 in the early 1960's and reached 300,000 in 1971. Annual bag limits of all kinds of ducks and other game birds reflect similar great increases of birds during the DDT years.

The raptorial birds are studied as they migrate over Hawk Mountain, Pennsylvania every year, and the reports are published by the Hawk Mtn Sanctuary. Those reports further document the increase, rather than decrease, of hawks of most kinds. Total numbers of hawks counted increased from 9,291 in 1946 to 13,616 in 1956, to 14,818 in 1961, to 20,196 in 1967, and (under slightly different procedure of counting) to 29,765 in 1968. Ospreys (which have been widely publicized as "in danger of extirpation" by Dr. Wurster's friends) were counted as follows: 1946 - 191; 1956 - 288; 1961 - 352; 1964 - 328; 1965 - 444; 1967 - 457; 1969 - 529 (new all-time high, again); and 1970 - 600 ospreys. Sparrow Hawks counted were: 1945 -98; 1956 - 192; 1961 - 470; 1965 - 408; 1966 - 579; 1967 - 666; 1968 - 736. HOW can these be considered as evidence of hazards to raptors from DDT in the environment??

Many species of birds have thrived so well in the DDT environment that they have become pests which man would like to eliminate or greatly reduce. Elder attempted to kill pigeons with DDT, but concluded that birds were NOT poisoned or reproductively hindered by even large quantities of DDT. Audubon Magazine Aug/Sept 1971 stated: "Today in a small area of northern Ohio ten million redwings mill about in the cornfields after the nesting season". The farmers point out that they swarm over the corn and destroy it during the nesting season, also, and they are crying for avicidal relief. In North Carolina the town of Scotland Neck complained last year that six million birds were ruining their town. The blackbirds polluted streams and ponds, laid 9 inches of droppings on the ground, and were killing a forest where they rested at night. The Virginia Department of Agriculture Bulletin (May 1967) stated: "We can no longer tolerate the damage caused by the redwing... 15 million tons of grain are destroyed annually - enough to feed 90 million people". But it has not been just the farmers and townspeople who were aware of the population explosions of birds during the DDT years. The Audubon Society last summer obtained permission from the Massachusetts Fish & Game Department to poison 30,000 gulls on one island along the Massachusetts coast... because they were too abundant and were a threat to the Terns that the Audubon Society preferred there. Along the California coast there are also too many gulls. They are a great environmental contaminant and are threatening the sea birds that share the offshore islands with them... including the Brown Pelicans on Anacapa Island. Gulls eat all sorts of contaminated food, including the entrails of fish along the shore... and those parts of the fish contain the heaviest concentrations of DDT and DDE of all!

EGGSHELL THICKNESS

Long ago the opponents of DDT despaired of proving that DDT in the diet had any harmful effects on the adult birds (or even the fledgelings). Instead, they changed their attack to concentrate on "eggshell thinning" because of DDT in the environment, in the diet, and in the eggs, or perhaps to decreased nesting success (due to a number of hypothetical causes). The thin eggshell theory has gained the broadest acceptance, and should be mentioned here.

Thin eggshells in the field: Dozens of publications indicate that there is NOT a correlation between levels of DDT in the environment, in the food of the normal bird, and the production of thin eggshells. When individual eggs are weighed, analyzed, and shell thickness measured accurately, it is quickly evident that the three characters vary independently. Attempts to use "means" and trickly statistical maneuvers have resulted in some publications purporting to "prove" a correlation where none actually exists. Such articles must be corrected by biometricians and statisticians before they criminally mislead students, laymen, and news meadia!

Other articles also demonstrate the lack of correlation between shell thickness and presence of DDT in the environment. Hickey & Anderson (1968, Science) show red-tailed hawk eggs in 1944 were 3,6% thinner than the pre-1937 shells (the thinning occurred two years before DDT usage could have caused it). During the next 10 years (to 1954) the shells became ~~still~~ thicker (2.7% thicker, in DDT years). Their Golden Eagle data showed 1940-1946 shells (before DDT) were 2.5 thinner than the pre-1939 shells, but by 1947-1965 period the eagles were producing shells 2.9% thicker than the pre-DDT shells. ANY CORRELATIONS SHOWN HERE INDICATE THAT DDT CAUSED THE SHELLS TO BECOME THICKER, NOT THINNER.

Krantz, et al, in Pesticides Monitoring Journal (1970) analyzed Bald Eagle eggs from Wisconsin, Florida, and Maine. They found the thinnest shelled eggs were from

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Florida (0.50 mm), next thinnest from Maine (0.53 mm) and thickest from Wisconsin (0.55 mm). Measurements of DDE (and DDT residue contents) showed an inverse correlation with shell thickness. . . Florida eggs contained 10.72 ppm DDE and Maine eggs contained 21.76 ppm DDE. (Wisconsin eggs contained only 20% the DDE level of eggs from Maine, yet were slightly thicker.)

Dr. Wurster stated in his address in Finland last year that it would be foolish to state that just because DDT or any other material is present, that means it is responsible for effects on birds. I entirely agree. There are many known causes of thin eggshells, and it is very irresponsible to point to DDT or DDE as "the cause." Thin shells are caused by several bird diseases, by lead, mercury, dieldrin, PCBs, by excitement, noise, fright, by calcium deficiency in the diet, by presence or absence of numerous other chemicals, by fluctuations or decreases in amount of light per day, by hot weather, by food shortages, etc. Sulfa drugs cause chickens to produce eggs with no shell at all, and Newcastle Disease causes eggs to be soft-shelled, misshapen, leathery in texture, or "chalky" on the surface. (All these symptoms of Newcastle Disease eggs match the appearance of the ruined eggs of the California Brown Pelican in 1969-1970, so perhaps the oil spill was accompanied by an outbreak of Newcastle Disease among those birds.)

Thin eggshells in the laboratory: The tendentious "experiments" designed to "prove" that DDT in the diet causes thin eggshells were especially disturbing to scientists. When Dr. Wurster's Environmental Defense Fund filed action against the U.S.D.A. Secretary to attempt to force him to ban DDT, they based their thin eggshell allegation on published work by just three research teams. Those were Bitman, *et al.*, Porter & Wiemeyer, and Peakall. Each of those teams intimated that DDT was responsible for thin eggshells, but it has now been broadly publicized that their "experiments" were incapable of "proving" that.

Bitman and his colleagues fed their quail only on calcium deficient diets, while at the same time forcing them to eat a very high level of DDT (100 ppm). The shells produced were 5% thinner than normal. Tucker & Haegele (Denver Lab of U.S.D.I.) demonstrated that quail maintained on twice as much calcium as Bitman gave his quail produced eggshells that were 9.3% thinner than normal . . . and they had NO pesticides in their diet! (Bitman's diet was 0.56% calcium and Tucker's diet was 1% calcium but quail should receive 2% to 3% calcium in their diet, if they are to produce shells of "normal" thickness.) After much criticism of Bitman's work, we were gratified to read his publication in *Poultry Science* a year or two later. With the same birds (quail) fed normal calcium diets, along with either 100 ppm of DDT or 100 ppm of DDE, Bitman reported no difference in eggshells produced by his "controls" or by those fed astronomical doses of DDT or DDE.

Porter & Wiemeyer fed their sparrow hawks a mixture of DDT and dieldrin. Since it was already reported that dieldrin alone causes thin shells it was not surprising that some of the sparrow hawks developed slightly thinner or lighter shells. It was certain NOT, however, proof that DDT caused thin shells!

Peakall (1970) suddenly reduced the artificial light from the 16 hours daily to which the doves were accustomed in his cages, to only 8 hours daily, while at the same time he began feeding them DDT. The result was that it simply took the doves longer to produce each egg . . . at least for awhile. (To cause thin shells, Peakall later had to inject massive amounts of DDE directly into the uterus of the birds.) Domestic poultry treated this way would have ceased laying entirely, and would have entered a premature moult! It did NOT prove DDT was responsible for causing thin shells! Peakall's theory for the thin eggshell phenomenon, disputed widely even before publication, was that DDT inhibited the

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production of an enzyme, carbonic anhydrase. Shortly after that theory was proposed by Peakall, several research teams at leading institutions published the results of years of research . . . all showing that DDT does NOT inhibit the enzyme! These researchers were: Dr. E. L. R. Stokstad (Head, Dept. of Nutrition, University of California, Berkeley) and assistant Eppie Chang; Dr. Yeshayan Pocker *et al.*, at University of Washington, Seattle; Dr. Bruce Switzer *et al.*, at University of Alberta, Edmonton; Dr. Maren and associates at University of Florida School of Medicine, and Drs. Sell & Davison at North Dakota University. The carbonic anhydrase inhibition theory has been *very* soundly debunked, but the Environmental Defense Fund activists continue to espouse it.

WHY ARE WE CONCERNED?

Sponsors of Science is an organization of concerned and sincere scientists. We share the dislike for environmental pollution, and we are deeply concerned for the safety of our wildlife. We are also concerned for the future of science in this country and throughout the world. We realize that the public and the press (and science students) *must* have confidence that they are being told the truth by scientists in high positions. When the truth is distorted, obscured, or deliberately debased, all science suffers. When the public loses respect for science and for all scientists, we will all pay heavily for that loss of confidence. We feel very strongly, therefore, that every effort must be made to *force* our colleagues to tell the truth . . . the *whole* truth . . . to the best of their ability. This has certainly not been done in the case of DDT and its role in environmental affairs. We urge scientists, conservationists, teachers, students, and the news media to join us in the attempt to prevent a continuance of the sort of misleading, fright-mongering pseudoscience that has become prevalent in recent years.

Sponsors of Science
1119 Waban Hill
Madison, Wisconsin 53711

Hawk Mtn. Counts (Pennsylvania)

TABLE I

SUMMARY OF HAWK MIGRATION 1934 - 1942, 1946 - 1967

	Turkey Vulture	Goshawk	Sharp-shinned	Coopers	Red-tailed	Red-should.	Broad-winged	Rough-legged	Golden Eagle	Bald Eagle	Marsh Hawk	Osprey	Peregrine	Pigeon Merlin	Sparrow Kestrel	Unid.	TOTAL
1934*	166	123	1,913	333	5,609	90	2,026	20	39	52	105	31	25	19	13	208	10,772
1935	374	293	4,237	553	4,024	181	5,459	9	66	67	153	169	14	20	123	23	15,365
1936	87	177	4,486	474	3,177	153	7,609	9	64	70	149	205	36	34	102	11	16,333
1937	44	49	4,817	492	4,978	163	4,500	4	73	38	189	201	41	10	141	8	15,719
1938	60	9	3,113	204	2,230	143	10,761	—	31	37	189	124	24	12	87	—	17,021
1939	146	26	8,529	590	6,496	314	5,736	8	83	64	273	174	38	43	181	—	22,791
1940	150	11	2,407	166	4,725	149	3,159	4	72	38	161	91	25	11	60	7	11,336
1941	182	21	3,909	416	4,700	198	5,170	2	55	50	254	201	44	35	196	38	15,471
1942	83	9	3,203	292	2,378	120	4,362	—	35	71	107	213	26	17	113	38	11,677
1943, 1944, 1945								NO RECORDS DURING	WORLD WAR II								
1946	64	32	2,409	221	2,358	248	3,280	—	69	42	171	191	26	20	98	62	9,291
1947	268	5	1,745	122	1,677	245	7,791	—	34	92	176	297	19	10	121	52	12,654
1948	300	14	1,651	203	2,499	268	15,454	10	40	88	186	170	33	19	142	96	21,173
1949	376	7	2,908	174	2,736	283	9,636	16	47	98	212	212	33	20	334	55	17,147
1950	64	6	3,719	263	2,669	346	6,638	2	68	142	223	323	35	45	253	120	14,916
1951	10	21	3,039	238	2,292	378	11,132	—	54	100	222	254	26	15	257	67	18,105
1952	19	7	3,659	308	2,555	347	12,629	9	80	114	309	343	32	45	210	73	20,639
1953	201	4	3,018	165	2,193	199	7,270	2	31	60	238	341	15	11	223	140	14,111
1954	43	96	3,220	194	2,072	311	5,911	3	40	77	151	336	29	28	176	93	12,730
1955	62	37	4,351	282	3,802	428	9,957	—	57	89	230	359	35	23	276	173	20,191
1956**	1	7	2,079	122	1,537	318	8,748	10	48	54	138	238	19	10	192	45	13,616
1957	220	81	2,674	203	2,744	216	8,949	9	46	39	187	319	15	22	175	98	15,996
1958	14	20	1,765	176	2,956	470	8,850	1	41	46	203	321	25	19	219	103	15,264
1959	186	25	2,819	170	1,911	344	5,282	12	31	41	257	288	33	17	281	82	11,779
1960	—	15	2,395	169	2,317	377	12,685	30	38	37	290	303	26	33	236	52	18,893
1961	129	89	1,753	108	2,606	333	8,403	56	52	51	283	352	23	13	470	117	14,818
1962	—	33	2,283	77	2,748	268	8,276	7	40	48	186	290	30	20	446	110	14,862
1963	178	28	1,528	73	3,474	210	9,824	11	28	30	178	190	21	27	262	101	16,163
1964	7	19	1,314	62	2,799	223	10,218	16	28	28	191	328	21	11	237	28	15,530
1965	84	102	3,498	103	3,305	303	9,318	4	34	43	190	444	14	23	408	113	17,986
1966	22	30	2,947	84	2,578	314	10,269	4	16	32	178	405	22	26	579	311	17,817
1967	3	32	3,243	101	2,630	374	12,052	7	36	38	244	457	22	20	666	221	20,196
1968	2	233	3677	220	4647	512	18,507	6	39	55	450	423	24	21	736	206	29,765

* Count includes only October and November.
Counts up to and including 1946 do not include figures for August.

**1956—Goshawk, Coopers and sharp-shinned hawks given protection under Penna. law for the months of September and October.

ADD → 1969 | 527
→ 1970 | 600

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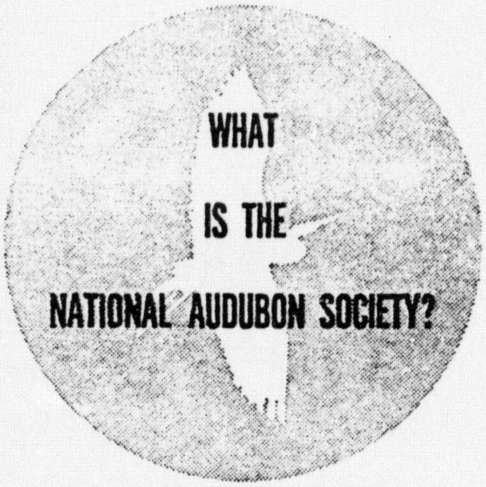
see pg. 3+4



WHAT IS THE NATIONAL AUDUBON SOCIETY?

Founded in 1905, the National Audubon Society is among the oldest and largest national conservation organizations in North America. Its purposes are:

- *to promote the conservation of wildlife and the natural environment, and*
- *to educate man regarding his relationship with, and his place within, the natural environment as an ecological system.*

ORGANIZATION & MEMBERSHIP. As of December, 1972, the Society had about 225,000 members, the majority of them organized into local chapters; there are 285 such chapters across America. Chapter members pay only the regular national membership fee, part of which is then turned over to the local group in a dues-sharing arrangement.

There are also some 275 garden clubs, community groups and other state and local organizations which are affiliated with the Society, paying a special organization membership fee. These are mostly groups that are not primarily concerned with conservation, but which wish to support the cause and become part of the Audubon Society team. Hundreds of thousands more Americans are reached every year through the nature centers, camps, film-lectures, educational aids and other programs listed elsewhere in this pamphlet.

Plaintiff's Exhibit 27

The Society is a non-profit organization which is entirely privately financed. It is supported primarily by membership dues, contributions, and bequests, all of which are tax deductible. Its combined operations now involve an annual operating budget of about 5¼ million dollars. Its Board of Directors, 35 in number, are elected by the members. The headquarters of the Society is in New York City, at 950 Third Avenue.

EDUCATIONAL SERVICES aid the Society's purposes directly by teaching children and adults, and indirectly by training teachers, providing educational materials and operating model teaching centers, so that others can teach conservation more effectively. Included are:

Audubon Centers. The Society operates five nature education demonstration centers at wildlife sanctuaries where there are nature trails and buildings for exhibits and other indoor needs. There are scheduled "outdoor laboratory" sessions, taught by professional naturalists, for school children, Scouts and others who come in organized groups. The centers are also open to those who wish to visit on their own during public visiting hours. In all, close to 100,000 persons of all ages visit the centers each year, many of them in family groups.

These centers have been among the Society's most effective ways of reaching the underprivileged youngsters of inner city areas. There is one center in California, just outside San Francisco; two in Connecticut, at Sharon and Greenwich (the latter is on the edge of the New York City area; one at the outskirts of Dayton, O., which includes both the Aullwood Audubon Center and the Aullwood Audubon Farm, and one in Milwaukee.

Audubon Camps are study workshops for adults who may enroll for one or two-week courses during the summer. They study the natural world chiefly through daily field trips, with emphasis upon the ecological relationships between all living things on earth, including mankind. There are four camps, situated in Maine, Connecticut, Wisconsin and Wyoming.

These courses are particularly recommended for teachers, who may bring back a broader understanding of natural resources to their classrooms; for youth group leaders; for conservation chairmen of civic groups, and for others with a special professional or hobby interest in nature and conservation. No technical background is required, however, and anyone over 18 who is interested is eligible to attend. Undergraduate and graduate university credit is offered at the connecticut, Wyoming and Wisconsin camps.

Since the first Audubon Camp opened in Maine in 1936, more than 20,000 men and women have attended the camps. More than half of them have been school teachers, a group that each succeeding year brings the Society's broad view of man's place in nature to an ever increasing number of students. For information on fees and schedules, write to our Camps Office.

Audubon Aids. To assist teachers, youth leaders and others who want to teach or study conservation subjects, the Society sells a variety of educational aids. Among them are:

Audubon Study Programs (formerly called the Junior Programs). Since 1910 these programs have served more than 12 million children. There are five fields of study; for each, workbooks are provided for the students and there is a special guide for the group leader, plus a large, explanatory wall chart. They are suitable for use in classrooms or by 4-H Clubs and other groups. Newest addition in this series is a study program in urban ecology, for grades 4, 5 and 6.

Nature Bulletins. These are non-technical, easy-to-read leaflets, 4 to 6 pages long. They are sold in sets covering various fields of natural history; the entire collection makes a valuable ready reference notebook.

Audubon Charts. In addition to the poster-sized charts mentioned above, 15 wall-sized charts are available, covering a variety of subjects.
[For details on these and other educational aids, write for our catalogue, *Audubon Aids in Natural Science.*]

PUBLICATIONS. The Society issues the following periodicals, in addition to various special reports, booklets, informational pamphlets and the like, which are published as needed:

Audubon, which is the official magazine of the Society, is an illustrated bimonthly. It contains authoritative articles on birds, mammals, insects, plants, marine life, pesticides, pollution and conservation activities. Its contributors include leading nature writers and photographers. Each issue carries a column by the Society's executive vice-president, a report from Washington on vital conservation legislation. *Audubon's* remarkable color photographs of wildlife, plant life and scenic areas are a byword among nature enthusiasts. There is a special back-of-the-book section with news and comment, covering topical conservation issues. The magazine is sent without charge to all members; separate subscriptions are available at $10.00 per year.

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American Birds, incorporating *Audubon Field Notes,* is a bimonthly journal devoted to the bird life of Canada and the United States. Recently expanded and renamed, it has become an unrivaled source of information on the everchanging distribution, abundance, and migratory movements of the North American avifauna.

Closely followed by professional ornithologists, serious amateurs, and Sunday hobbyists alike, *American Birds* now publishes important articles on major problems, news of research in progress, university profiles, a calendar of trips and tours, outstanding photographs, and other regular features. Four seasonal issues present data submitted by field observers to 20 regional editors, each of whom analyzes the records and prepares a report, with emphasis on changes in distribution and abundance. The overall picture is summarized in the "Changing Seasons" column, an analysis of patterns, fluctuations, and trends to be watched. In addition, *American Birds,* annually publishes the Christmas Bird Count (April), the Breeding Bird Census (December), and the Winter Bird Population Study (June). Published in collaboration with the U.S. Fish and Wildlife Service. Subscription: $6.00 for one year. $11.00 for two years.

Audubon Leader. A printed newsletter is sent to officers of the Society's chapters and affiliated organizations twice each month. It summarizes legislative matters of concern to conservationists and other news and information of interest to leaders of local groups. Individual subscriptions available at $5.00 per year.

AUDUBON SANCTUARIES. The National Audubon Society protects 50 different areas of land and water as sanctuaries. These range in size from small, offshore islands to one 26,000-acre block of coastal marshland. The primary purpose of most Audubon sanctuaries is to protect nesting or roosting areas of threatened species of birds from disturbance. Therefore most of the sanctuaries are not open to the public and can be visited by members only through special arrangement. Major exceptions are the sanctuaries run in connection with the educational programs of the Society's camps and nature centers, and the 11,000-acre Corkscrew Swamp Sanctuary, near Naples, Fla., where a mile-long boardwalk provides public access to the world's largest remaining strand of virgin bald cypress swamp.

Because state and federal wildlife agencies have been providing refuges that are primarily for game birds, the National Audubon Society has been concentrating on the protection of the non-game species. The bulk of the patrol work by a force of 18 Audubon wardens is in Florida and the coastal areas of Louisiana, Texas and California.

NATURE CENTER PLANNING DIVISION. This division aids other organizations to establish and develop nature centers of their own. The Society's specialists work with local, private and governmental groups that wish to acquire natural areas and operate their own centers, and also with land-use agencies, educational institutions and industrial concerns which wish to promote educational use of their properties for nature appreciation and study. Fees are charged which defray part of the costs; the remainder of the expense is met by foundation grants and contributions. *Nature Center News,* a quarterly newsletter of national news and comment about nature centers, is sent to a selected list of interested individuals and organizations.

AUDUBON SCIENTIFIC PROGRAMS. To find ways and means of saving and restoring populations of birds and other animals threatened with extinction, the Society maintains an important field research program and publishes research reports. This work is sometimes done in cooperation with universities or government agencies. Studies have been made of the ivory-billed woodpecker, roseate spoonbill, whooping crane, California condor, American flamingo, bald eagle, golden eagle, and others.

In addition, the Society has a scientific program for gathering and evaluating technical data as needed. The modern conservation organization may be called upon to take positions and speak with authority on a wide range of complex resource problems. In 1971 the Society entered into a cooperative agreement with the Massachusetts Audubon Society, creating a Joint Scientific Staff and adding a physicist and an economist to a staff already strong in the biological sciences.

AUDUBON WILDLIFE FILMS are color motion picture programs on wildlife, conservation and the out-of-doors, presented in person by naturalists and wildlife photographers in 260 North American communities.

The sponsoring organizations include colleges and universities, science clubs, Audubon chapters and affiliates, garden clubs, service organizations and any others wishing to add to the cultural entertainment and educational opportunities of their communities. Audubon speakers journey all over the world to film complex and fascinating plant and animal relationships. Most sponsors schedule five programs during a season: in all, up to 1500 are presented each year.

OTHER SERVICES AND ACTIVITIES The staff of the National Audubon Society, in addition to administrative duties, performs other special functions:

Naturalist Training Program. Only a limited number of openings are available in this important program which offers an intensive 13-week on-the-job training experience for qualified college students and others heading for professional nature center work. There are fall and spring sessions.

Library. The Society maintains a library of over 18,000 books, pamphlets, and periodicals, most of which are devoted to birds and to conservation, the rest to general natural history and related subjects. Particular features are comprehensive collections of ornithological journals and publications of the Society's chapters and affiliates. The library, for reference only (the volumes are never loaned), is open to members and the public Monday through Friday by appointment only: call (212) 832-3200, Ext. 270.

Photo and Film Service. The Society has one of the largest and finest collections of nature photographs in the country. It has both black and white prints and color transparencies of birds and other animals, plant life and scenery. It acts as agent for nature photographers, making their work available to educational and commercial publications and to television outlets, and collecting the photographers' fees. For projection in schools and at meetings the Society maintains a large collection of Kodachrome slides for sale, plus a limited selection of color, sound, 16mm motion pictures, which it rents for nominal fees.

Service Department. This department handles mail order sales of standard nature books, bird-call records, prints for framing, Christmas cards, note paper, jewelry and emblems with the Audubon insignia, and some other special gift items.

Public Information. As a part of its program to keep the public well informed on conservation matters, news releases are issued to the press and to affiliated groups and other cooperators. Close cooperation is also maintained with newspapers, magazines and book publishers, radio and television. Continuing campaigns are conducted on behalf of endangered and persecuted species such as the alligator and the bald eagle, and in support of such basic goals as water pollution control and preservation of wetlands.

Legislation. The Society believes that constructive public policies affecting natural resources require an informed public opinion. Many of its activities are thus calculated to develop citizens who are alert, knowledgeable, and articulate about conservation. Attempting to influence current legislation is not a substantial part of the Society's work. However, the Society tries to keep its members informed on conservation controversies and problems, and, when invited to do so, representatives of the Society on occasion testify at local, state or federal public hearings. An office is maintained in Washington, D. C.

PERSONNEL. There are some 90 employees at the Society's headquarters, including staff executives, clerks, accountants and other headquarters personnel. About 75 others are stationed at centers, sanctuaries and other field locations, not counting an additional fifty or so engaged in summer camp teaching and administration, and 40 part-time lecturers.

The Society also has established offices in nine regions across the country, each headed by a National Audubon Regional Representative, to encourage growth and co-ordination of local Audubon societies. The representatives are:

(Northeast) J. S. Quickmire, Jr., Orchard Hill Road, Harwinton, Conn., 06790.

(Mid-Atlantic) Alan J. Miller, 17 Vreeland Road, R.D. #4, Newfoundland, N. J. 07435.

(Southeast) W. Carlyle Blakeney, Jr., Suite C7, 4651 Roswell Road N.E., Atlanta, Ga., 30342.

(Central Midwest) John L. Franson, 1020 E. 20th St., Owensboro, Ky., 42301.

(North Midwest) Edward M. Brigham III, R.R. #4, Roving Hills, Red Wing, Minn., 55066.

(West Central) Ronald Klataske, R.R. 2, Alma, Kan., 66401.

(Southwest) John L. Spinks, Jr., P.O. Box 9585, Austin, Tex., 78757.

(Rocky Mountain) Robert K. Turner, Box 3232, Boulder, Colo., 80303.

(Western) Paul M. Howard, Jr., P.O. Box 4446, Sacramento, Calif., 95825.

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WE HOPE YOU'LL JOIN US

The National Audubon Society is a growing army of Americans committed to conservation. Our aim, in simplest terms, is to protect the natural environment: to keep our world livable—and worth living in. By joining us you help support the programs and activities described in this leaflet, and become an active member of the conservation movement. Membership is open to all.

Regular	$ 12.00
Student	6.00
Family	15.00
Sustaining	25.00
Supporting	50.00
Contributing	100.00
Donor	250.00
Life	1000.00

Membership includes *Audubon* magazine. Send check and your name, address and zip code to the Director of Membership at the address below.

Affiliate (organization)	$25.00

This organization membership, designed for non-chapter Audubon groups, bird and nature clubs, garden clubs, and other community groups, includes one subscription to *Audubon* magazine and the Society's semi-monthly newsletter.

NATIONAL AUDUBON SOCIETY
950 Third Avenue
New York, N. Y. 10022

EXHIBIT
J. S. DIST. COURT
S. D. OF N. Y.
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EDITORIAL NOTE

As an uninvolved devotee of Audubon Field Notes, our interest in the traditional Breeding Bird Census number was somewhat less than impassioned. It was always our feeling that this was indeed valuable field work, but very poor reading, and after the most casual of perusals we would consign the December number to the files.

Therefore, as editor, we have been required to examine each census word-for-word, and this year we discovered how much fascinating reading is being offered in these pages. This is living documentation, with sometimes dramatic warnings revealed, of the state of our breeding avifauna in sample tracts of North American habitat.

The problem is that there is simply not enough of this research being done. Everywhere in Canada and the United States are neglected regions and habitats that cry out for attention. If we are ever to know our prese base-lines of populations and our "norm densities (which are increasingly precious seeking to protect those populations and hab tats which are threatened), we must enli growing corps of volunteers as dedicated those represented here. This work is not pa ticularly arduous, nor is it technically de manding: it can be done by amateurs: the reward for individuals or groups is the par cipation in a worthwhile continent-wide en deavor. It is recommended to every serious b student whether or not affiliated with sponsored by an institution. Instruction folde are available from this office: there is time to participate this year in a Winter B Population Study, and to add a Breeding B Census on the same plot next summer. The is no more valuable field work waiting to done.—R.S.A.

Deciduous
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Deciduous
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7. U
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H
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25. Mi
26. Se
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27. Se
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28. Sec
Pin
29. Se
Pin
30. Sec
Pin

Vol. 24 1970

To CHC, CB, RB, RArbib 14 August 1972

From RCClement Re: Christmas Bird Count data

Jack Devlin's NYTimes piece on the misuse of our Christmas Bird Count data unfortunately confuses the issue and puts us in a bad light re calling people "liars".

1. We should never call anyone a liar unless we have evidence concerning his personal motives. People may be incompetent, biased, misinformed, etc., but only they know whether they are lying unless we have been privy to some revelation to the effect that they are wilfully misusing information.

I have accused some of these people of "intellectual dishonesty", not far from the common word "liar", but this is a fine distinction pointing to the fact that these people have enough knowledge to avoid the conclusions they publicize; i.e., they have been guilty of selecting facts, neglecting others, improper emphasis, etc.

Some people misrepresent because they are paranoic in their defense of a contrary point of view.

2. Arbib did not accuse any particular individuals of lying, though he did say that those who misused our data were either "being paid to lie, or parroting something he knows little about."

He did, by interview with Devlin, identify White-Stevens, Jukes, Borlaug, Stevens and Edwards as notorious misusers of our data, and implicitly either paranoic, incompetent, or intellectually dishonest.

3. Devlin did us a disservice by leaving out the real qualifications that make our Christmas Counts unreliable raw data for comparisons of total bird populations from one decade to another, viz.: "better access to the Count areas, better knowledge of where to find the birds within each area, and increasing sophistication in identification." Unfortunately, in a subsequent sentence, Arbib said, "not more birds, but more birders", which is not so; he should have said, "more and better birders".

Plaintiffs Exhibit 29

Our Counts do of course, as raw data, show "more birds" reported, and our opponents are not so stupid as to have missed reducing these numbers to "birds per observer hour", which they think is sufficient refinement. But it is not, because the observer himself has changed over the year.

Our data have many uses (mapping distribution, winter density, etc.) but not to show changes in species numbers over the decades.

devlin-

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BIRD

S U M M A R Y

The National Audubon Society accuses "segments of the pesticide industry" with having "certain paid 'scientist-spokesmen'" who have been putting out "false and misleading distortions for the most self-serving of reasons." The charge is made in the publication, American Birds, which contended that ~~some of the people are~~ such a person is "being paid to lie or is parroting something he knows little about" when he says Christmas bird counts show bird populations are increasing. The publication did not identify by name the men it was attacking but did give the names of some when the author was interviewed, and they disputed the charge and once said it was "obviously libelious."

DEFENDANT'S
EXHIBIT
U. S. DIST. COURT
S. D. OF N. Y.
AUDUBON A

devlin-

760e

BIRD (for sunday editions)

Bird got- R.C. [illegible]

[illegible] - [illegible]

S U M M A R Y

The National Audubon Society accuses "segments of the pesticide industry" with having "certain paid 'scientist-spokesmen'" who have been putting out "false and misleading distortions for the most self-serving of reasons when they contend bird life in North America is thriving,"as indicated by annual Christmas bird counts conducted by bird watchers. The Audubon Society contends contends that actually the reason for the increase in the number of birds reported, despite the heavy use of pesticides, is that there is "an enormous growth in popularity" of the annual Christmas bird counters.

[illegible] DOT -

EXHIBIT
[illegible] AUDUBON A-5 [illegible]
DATE 11-14-74
MINDY A. KIRSCH MK

Defendant Audubon Exhibit A(5)

devlin-

BIRD-

Audubon 761 e

DEFENDANTS
EXHIBIT
U.S. DIST. COURT
S.D. OF N.Y.
a(6)

Aug. 11, 1972

S U M M A R Y

Some "segments of the pesticide industry and certain 'scientist-spokesmen'" are accused in the current issue of American Birds of "lying" by saying North American bird life is thriving despite the use of DDT. The publication is put out by National Audubon and U.S. Fish & Wildlife and acarries results of the last (72d annual) Christmas Bird Count. Names of those accused are not published in the American Birds report but several were identified over the phone when I called them and they entered angry denials and one said the charge was "almost libelous."

delete

762e

①

[illegible] [illegible] [illegible] #

Pres. of [illegible]

Roland Clement

Environmental Science

[illegible] Science Club

biochemist ... well [illegible]

Read

1 - Dr. Tho. H. Jukes - biochemist well

Univ. of Calif. ~~Berkeley~~ 94720

Science Summit [illegible] [illegible] [illegible]

(415) 525-0469

2 - Robt. H. White-Stevens

Rutgers College

[illegible] of Am. Cyanamid - of

New J. Rutgers [illegible] Commission

Environmental Science

(201) ~~[illegible]~~

249-1447

3 - Norman E. Borlaug -

Nobel ~~[illegible]~~ Prize

1970

for his - [illegible] - Mex.

Rock. Foundation

4 - Entomologist

J. Gordon Edwards

San Jose State Coll. Calif.

5 - Donald A. Spencer -

Dept. of Agri.

Natl. Agric. Chem. Assn.

DEFENDANT'S

EXHIBIT

[illegible]

AUDUBON B

763e

Jukes – ~~[illegible]~~ "Crop Life"

DDT – [illegible] [illegible] [illegible] [illegible] [illegible] 1971

[illegible] + middle class

Tantamount to "[illegible] [illegible] in a religious sect."

Mythology of Silent Spring

W. Stevens On the Rachel Carson

Philip H. Marvin
[illegible] [illegible] [illegible] [illegible] DDT.
"[illegible] [illegible] [illegible] [illegible] [illegible]
pesticide yellow". –"
~~"Crop Life"~~
[illegible] "Crop Life" May '64

764e

J. Gordon Edwards
[illegible] [illegible]
pro DDT

#

E. [illegible]
DDT – birds
#
some [illegible] [illegible]
big DDT producers –

Brown pelican
3,000 active nests
80–100

Island

[illegible] two
eggs

in [illegible]
till Sept.)

Dr. J. Gordon Edwards =
Prof entomology
San Jose State
" "
95114

[illegible]

408 ~~274-6414~~ –

277 – ~~[illegible]~~ 2350

④ 765 e

[illegible]

Mid [illegible]

27. 800. 000

love.

US.

Jan.

Waterproof pages

Guide.

"Rudder of the Ocean"

W B Alexander.

Partner

"Love's Words"

Statements - not made
for [illegible]

almost deletions only
[illegible] of real ideas.
I think it [illegible] if we
[illegible]

[illegible] we [illegible]
disagreement if we [illegible]
[illegible].

16 [illegible] wild-life
need [illegible] judgements.

[illegible]

Aud. Soc. [illegible] count [illegible] 1948
[illegible] - [illegible] 18,000 +
[illegible] bird
in 171 count [illegible] places
members [illegible]
15 [illegible] 1 or 2 [illegible]
[illegible] elsewhere
It is not [illegible] circles

Defendant Audubon Exhibit B(1)

more [illegible] 767 e

Counts have value for scientists

+

Cattle egret flew in U.S.
spread out

Count very valuable
but accuracy not
as a census -

Last 70 years
more wildlife

As many birds today as 50 years ago
But species shift.
All 110% [illegible] Survey

Nation lost 125 species, extinct
over 100 yrs prior to 1925

1 [illegible] lost
None lost since 1950 -

③ 768 e

Budget —

We get [illegible] motions.

[illegible] construction

Cont'd. —

View [illegible]

It is not [illegible] ~~stable~~.

[illegible]

Boeing [illegible] US [illegible]

34 [illegible]

[illegible]

Dry [illegible]

Side effects of chemicals are

[illegible]

[illegible] Chem. Assn.

[illegible]

It will be hard to [illegible] trade.

(4)

? { [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] }

An interpretation.
The meaning of being

[illegible] the [illegible]
Wow.

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

---

1 a [illegible] of
[illegible] Soc.

Summarize (an effect)
We do have extremists
[illegible] on both sides

770 e

The Pesticides Controversy

ROLAND C. CLEMENT

Reprinted from Environmental Affairs
Volume, 2, Number 3, Winter 1972

DEFENDANT'S
EXHIBIT
U. S. DIST. COURT
S. D. OF N. Y.
AUDUBON D

771 e

Reprinted from ENVIRONMENTAL AFFAIRS

Vol. 2, No. 3, Winter 1972

THE PESTICIDES CONTROVERSY

By Roland C. Clement[*]

INTRODUCTION

A recent article in ENVIRONMENTAL AFFAIRS[1] purports to "evaluate the evidence" in what is alleged to be "an intensive campaign to ban the insecticide DDT from use in, manufacture in, and export from the United States" in the past two years (i.e., since 1969).

Its author, Thomas H. Jukes, is a biochemist and presently a professor of medical physics at the University of California, Berkeley. He also has been the most vocal defender of the use of DDT. But to be helpful, any assessment of the anti-anti-DDT reaction articulated by Jukes should include comparison of the very similar pronouncements of Robert H. White-Stevens, a former colleague of Jukes at American Cyanamid Company and now professor in the Bureau of Conservation and Environmental Science at Rutgers University; Norman E. Borlaug, 1970 Nobel Peace Prize winner for his contributions to the production of high-yield wheat in Mexico; J. Gordon Edwards, entomologist at San Jose State College; and Donald A. Spencer, a wildlife biologist formerly with the U. S. Department of the Interior, but more recently with the U. S. Department of Agriculture (USDA) and the National Agricultural Chemicals Association (NACA), an industry trade group.

As an unecological rationalization of the food production needs of the rest of the world, the defense of DDT in this country is understandable, and could be dealt with on its merits. But most of the defenders of DDT mentioned above have recently engaged in intemperate attacks on the National Audubon Society and the Environmental Defense Fund, the two private conservation groups who have been the principal challengers of the continuing use of DDT in this country.

Jukes wrote that "The National Audubon Society, which appears to have a predominantly white and middle-class membership, is one of the most active anti-DDT organizations. For a member to condone the use of pesticides would be tantamount to the deepest heresy in a religious sect. For an official of the Society to approve such use would be fiscal lunacy, in view of the tremendous amount of free publicity that the Society has received as a result of SILENT SPRING and other publications which have established a new mythology—the extermination of wild birds by agricultural pesticides. The Society shows underlying resentment of human beings and all their works, including cities, farms, highways, and especially private industry. Membership in the Society is a form of expiation of the sin of being one of the human race, the species that consumes "the environment." The Society stated recently that one of its two main purposes is 'the education of man regarding his relationship with and his place within the natural environment as an ecological system.' This pious pronouncement is actually intended to exclude man as an inhabitant of the Earth, except in small numbers and in a primitive, mythical, aboriginal state. The Audubon Society has no program for the relief of suffering among millions of human beings in the tropics." This, I suggest, is unreasonable and even malicious.

Robert H. White-Stevens has been, since 1963, the most avid anti-Rachel Carson lecturer and pamphleteer in this country. He quickly embraced, embellished, and gave widespread publicity to the Philip H. Marvin[2] thesis that the National Audubon Society's own data (especially the Christmas Bird Counts held annually since 1900 and published in what is now AMERICAN BIRDS) "prove" that birds have increased in numbers despite the use of DDT and other pesticides.

White-Stevens[3] poses the rhetorical question, "What does a critical examination of these bird data over the past twenty years reveal, particularly in the light of the introduction of synthetic pesticides in the early forties?" His answer is that "First, by the most conservative estimate the overall count reveals a bird population increase of at least 700%, which more than matches that of the human population." Why that last comparison is significant we are not told. "Second, with the exception of swans, ducks, doves, partridges, and pheasants, birds that are vigorously hunted, all other birds are either holding their own comfortably or are increasing at a prodigious rate. Thus robins, over which Miss Carson despairingly cries requiem as they approach extinction, show an increase of nearly 1200% over the past two decades." Finally, White-Stevens, the fighter of myths, creates one of his own when he opines that "So many bird species have increased their numbers so substantially and have extended their living space so far that one is tempted to pursue Miss Carson's logic and make out a case for pesticides as being the major cause of bird survival through the reduction of insect-vectored avian disease."

Unfortunately, hundreds of agricultural experiment station newsletters and newspaper columns—the latter augmented by more hundreds of garden columns in newspapers and magazines—repeated this hoax of bird population increases and told the public that "the Audubon Society itself said (or admitted) birds are increasing," and that DDT and its relatives were at least in part responsible for these increases.

It has been impossible to rebut this inundation of distorted claims in the popular press in the last decade. Marvin[4] eventually published his thesis in a proper scientific journal; and E. E. Kenaga[5] promptly showed the entomological community that Marvin's ornithology was inadequate, and that crude summations of Audubon Christmas Bird Count data was not evidence upon which Marvin, White-Stevens, and Jukes could base a defense of DDT. It is noteworthy that all of the DDT apologists have been chary of normal scientific channels for the publication of their purported proof of the safety of DDT and its need in world agriculture. Instead they have assiduously burdened the popular press and other media with their alarums. Jukes published in AMERICAN SCIENTIST[6] but was quickly rebutted in the same publication by F. E. Egler.[7] Nor do any of them seem willing to benefit from the warnings of ornithologists[8] about incompetent use of ornithological data.

Norman E. Borlaug is the most recent, and because he is a Nobel laureate, the most newsworthy recruit to the anti-anti-DDT camp. It should be noted that his 1970 Nobel Prize was for contributions to world peace—via food production—and not for contributions to science. Following Borlaug's appearance at the Environmental Protection Agency's (EPA) 1972 hearings on the cancellation of DDT, a press conference arranged for him by Montrose Chemical Company, the principal manufacturer of DDT in this country, received much wider public attention than any of the scientific testimony presented during the six months of those hearings.

Borlaug's principal brief[9] is a 1971 McDougall Memorial Lecture delivered at the United Nations Food and Agriculture Organization (FAO) conference in Rome on November 8, 1971. The first half of this long talk was a paean to modern agriculture and the dilemma of human overpopulation. It made the usual emotional errors of agriculture's boosters in claiming, against all recent scientific evidence, (1) that primitive man was forced "to expend virtually all his energies in struggling to feed himself;" (2) that in modern nations such as the U.S.A. "only 5% of the labor force is engaged in farming and ranching;" and (3) that governments "must assure a reasonable return to the farmer and rancher, if they are not to drive the smaller operators off the farms and into the slums of the large cities.

The second half of the FAO lecture is a diatribe against environmentalists, especially the National Audubon Society and the Environmental Defense Fund, along with a lengthy agenda of proposed tasks to divert these conservation groups from their "misdirected" challenges to the use of DDT. Dr. Borlaug's concerns about the food production needs of an overpopulated world are valid but poorly expressed; but his talks, far from providing the insights one expects of a Nobel laureate, obfuscate the issues and distort the contributions of American conservation groups who have, for a quarter-century, attempted first to educate, and now to counter by court challenges an arrogant, environmentally myopic, and commercially-oriented coalition of the USDA and segments of the chemical industry.

J. Gordon Edwards is also a relative newcomer to the pesticides debate, and another who has never published so much as a scientific note on DDT or birds, both areas he now professes to analyze professionally. He is in many respects the most difficult of our critics to understand. He writes and lectures extensively and has had "a good press." On March 18, 1971 he testified[10] before the House Committee on Agriculture and his testimony was given wide circulation. A condensed version was distributed in pamphlet form by Terra Society, a new organization which purports "to serve the needs of man in his total environment through research and education on chemicals and their use to improve the physical and aesthetic standards of the world." Terra Society says it chose to distribute Dr. Edwards' broadside "because this man's testimony . . . analyzes the predominantly circulated arguments used to attack DDT."

The Edwards testimony, like all his attacks on those who would ban DDT, is so wide-ranging, so replete with distorted references to scientific literature, and so sprinkled with unsupported opinion that it is difficult to comment on except on a line by line basis. Dr. Robert B. Finley, Jr., a respected investigator of wildlife-pesticides relationships at the Denver Wildlife Research Laboratory, U. S. Bureau of Sports Fisheries and Wildlife, was so incensed by the distortions Dr. Edwards introduced into the hearings that he wrote Chairman W. R. Poage a 14-page (single-spaced) critique on August 2, 1971. These corrections were unfortunately not published with the record of the hearings. Such Congressional hearings point up the futility of trying to present "both sides" of a controversy when the proponents of different points of view are allowed to operate on different levels of presentation. The advocates of *status quo* in the use of pesticides often decry recourse to the courts as "unscientific."[11] Court hearings, however, at least have the merit of presenting testimony under oath and subjecting witnesses to cross-examination.

Donald A. Spencer's most quoted input to the pesticide controversy is a twenty-page leaflet, *An Ecologist Views the Environment,* first distributed in large quantities in 1970 by NACA—to schools, agricultural experiment stations, U. S. Forest Service field offices, congressmen, etc. Although touted as "one of the country's outstanding authorities on wildlife biology" by his employer, NACA, Dr. Spencer spent most of his career as a small mammal control specialist, testing the effectiveness of various chemical poisons on mice. A thirty-title bibliography of his technical publications is almost entirely devoted to small mammal control, the one field in which he was an acknowledged expert. It should be noted that although scientific research on birds has provided the most telling evidence of environmental contamination by pesticides, Spencer's leaflet contains not a single citation to the extensive literature on bird-pesticide relations.

Perhaps the most telling rebuttal of Spencer's recent writings on behalf of the chemical pesticides industry is the fact that in June 1971 the Wildlife Society—the professional wildlife management association—was moved to publicly denounce Dr. Spencer, one of its own members, in these words: "A pamphlet by Donald A. Spencer entitled *An Ecologist Views the Environment,* published and distributed by the National Agricultural Chemicals Association, has caused serious concern among many members of The Wildlife Society.

"In the opinion of the Wildlife Society, it is a skillfully-prepared document of a familiar kind, in which the facts are selectively chosen and assembled in a fashion that makes a particular case rather than putting the hazards of using persistent pesticides in accurate perspective.

"The Wildlife Society is convinced that the document gives false assurances of safety and security of wildlife populations, and that the most significant facts concerning the effects of persistent organochlorine insecticides on wildlife are omitted or discounted. The Society believes that selections, omissions, and irrelevant inclusions are typical procedures followed throughout the document.

"The Wildlife Society considers the pamphlet to be misleading and a disservice to conservation of wildlife and the environment. This statement is endorsed by the Council of the Society."[12]

Most interestingly, following a heated television debate in Detroit, Spencer insisted that he had not authored *An Ecologist Views the Environment*, but that this had been pieced together, presumably by a public relations firm, by lifting "out of context" items from his various written talks.

HISTORICAL SKETCH

Before exposing more of the irrationalities involved in the diatribes of this quintet of DDT apologists, it will add perspective to outline the history of the 25-year pesticides controversy. It is an important chapter in the history of science and technology.

As the first of a long series of synthetic chemical insecticides introduced into general use by industry, with USDA approval after World War II, DDT is a classic example of technology outrunning the science supposed to protect us from the misapplications of technical know-how.

First used by the military in World War II, mostly in powder form, DDT undoubtedly saved millions of lives from typhus, malaria, and other insect-borne diseases, both during and after the war. Post-war uses, however, involved DDT in oil or other solvents—mostly to facilitate aerial application over large areas—and this made it lipid (fat)-soluble. Our troubles began here.

At first it was thought that the chief problem was merely one of determining optimum use—no more than one pound of DDT to the acre, or one-half pound over water, because it was soon observed that fish and other aquatic forms were particularly vulnerable. Compared to many other insecticides, DDT is not highly (acutely) toxic, but this is unfortunately deceptive, since it is now known that its chronic toxicity is its most pernicious effect.

The first scientific clue to this delayed effect (chronic toxicity) came to light in 1958 when Dr. Roy Barker[13] of the University of Illinois discovered that DDT applied to elm tree foliage in the spring of one year could kill robins a whole year later. Several field studies[14] demonstrated that this particular use of DDT was very destructive of bird life. One can perhaps control excessive dosage, but there is no protection against low-level accumulations of DDT.

The biologist is not concerned about birds *per se,* since he knows that ordinary mortality in birds and other wildlife species is normally compensated for, but he sees birds as a sensitive indicator of environmental quality—a sort of litmus paper test. He is concerned about the welfare of life processes themselves when some population imbalance (birds, fish, or others) warns him that something is going wrong with our life-support systems—the plant-animal communities that keep the planet productive and livable.

The long-lived characteristic of DDT[15] (up to 50% of it may remain active in the environment a full ten years), and its fat-solubility, cause it to be cycled in nature's food webs, and to be magnified in the process. Although barely soluble in water (and thus neglected as "insignificant" for years), we now know that it is magnified hundreds or even thousands of times in being passed from one food level to another—and that it ends by killing or severely handicapping species at the ends of long food chains. Man himself is one of these "last guys" in the food chain system.

By 1960 we knew that DDT was causing serious damage to living systems out-of-doors, but we did not yet know the exact mechanisms of damage. In 1964, New York scientists[16] learned that as little as 3.0 parts per million (ppm) of DDT in lake trout eggs would kill the young fish fry at the egg-yolk absorption stage. Fish and birds became the test animals in a vast scientific detective hunt for the mechanisms of DDT poisoning. We knew that millions of robins were being killed in the northern U. S., that peregrine falcons had stopped nesting in the eastern U. S., that pelican populations had collapsed on the Gulf Coast of Louisiana and Texas, that bald eagle populations and fish-eating osprey populations were also collapsing in many parts of their range.

In 1967–68 a series of scientific discoveries began to provide the missing links in our understanding of what was happening to wildlife. Following a scientific conference on the disappearance of the peregrine falcon in the eastern U. S. (held at the University of Wisconsin in 1965[17]) a British researcher, D. A. Ratcliffe[18] discovered that peregrine eggs laid after World War II had shells roughly 20% thinner than a similar sample laid prior to 1945, when DDT and similar pesticides (dieldrin, aldrin, endrin, heptachlor) came into use in agriculture, public health, etc. Dr. J. J. Hickey and co-workers[19] at the University of Wisconsin soon confirmed that the same thin-eggshell phenomenon exists in several U. S. bird populations (pelicans, eagles, peregrines, etc.).

At about the same time other researchers[20] working with rats as test animals discovered that dieldrin (and, later, DDT) causes the liver of exposed animals to manufacture an enzyme not normally present in these animal systems. This same enzyme induction was soon shown to be operative in several bird species, and scientists at the Patuxent Wildlife Research Center of the U. S. Fish & Wildlife Service then demonstrated[21] that the thin egg shells and the attendant lowering of reproductive success (50% to 75% mortality) so widely observed in nature were reproducible under scientifically controlled experimental conditions. DDT, its breakdown product DDE, and dieldrin, all interfere with body physiology in rats, several bird species, and man. We are not yet sure of the implications of enzyme induction by DDT in man except that it complicates the prescription of drugs, since doctors should now know DDT levels in their patients before prescribing such drugs as phenobarbitols.

Beginning in 1969, several scientific reports appeared which firmly implicated DDT as a causative agent in cancerous growths (carcinogenicity) in test animals. The evidence is similar in nature to that which caused the Food and Drug Administration (FDA) to ban the use of sodium cyclamate in American diets in October 1969. Thus on November 12, Secretary Finch of the Department of Health, Education and Welfare (HEW), asked the Departments of Agriculture and Interior to join him in "phasing out" the use of DDT within two years.

Just as the controversy over the health effects of smoking tobacco continues, almost wholly because of economic commitments, a full ban on DDT will continue to be resisted. But many feel that the evidence is in, and that positive action is now overdue at federal, state and local levels. Thus we applaud the June 14, 1972 decision of William D. Ruckelshaus, Administrator of the EPA to cancel all but a few minor registrations of DDT, thus announcing a virtual ban on this chemical in the United States effective December 31, 1972.

The National Audubon Society was the first national conservation organization to warn in 1946 of the environmental hazards involved in the "massive" use of DDT, i.e., in aerial applications covering widespread areas.[22] For two decades thereafter, Audubon officials attempted again and again to enlist the cooperation of the USDA in limiting the uses of DDT and related pesticides, always with minimal results, and often at the price of being derided as alarmists.

The first concerted opposition to USDA pesticides programs developed in 1959 when all the major conservation organizations joined in opposing the fire ant eradication program in the southeastern U. S. This program still continues at a "control" level, but opposition at least forced the USDA to "discover" that half a pound of heptachlor to the acre would control ants as well as the two pounds originally prescribed by its experts. When, after years of advocacy, it was discovered that heptachlor degrades to an even more toxic epoxide when released in the environment, the less toxic but still environmentally objectionable chemical Mirex was substituted. A major court challenge against the USDA's gypsy moth eradication program was launched by ornithologist Robert Cushman Murphy in 1957, and was finally defeated in the U. S. Supreme Court in 1959; but this suit at least caused the USDA to reconsider and largely abandon its eradication approaches for well-established pests.

Little else changed until Rachel Carson's Silent Spring (1962) was read by more than a half-million people, including President John F. Kennedy. This led to the formation of a host of pesticide review or pesticide control boards and committees at state and federal levels, and the production of two President's Science Advisory Committee (PSAC) reports.[23] Although the 1963 PSAC report agreed that most of Rachel Carson's concerns were valid, and although the committee made several forceful recommendations, few were acted upon, and none with enthusiasm until—having exhausted administrative remedies—the conservation groups took their case to court and exposed the arbitrary and inadequate pesticides registration process of USDA. The National Academy of Sciences—National Research Council[24] tried twice to grapple with the pesticides problem, but failed each time, largely because it was dominated by chemists.[25]

In 1967 the National Audubon Society underwrote the costs of making a transcript of a new DDT court challenge, a new series of class actions, in the hope that this would further expose the issues to public scrutiny and overcome entrenched bureaucratic conservatism. The plaintiffs were a small group of Long Island, N. Y., residents who shortly thereafter formed the Environmental Defense Fund, Inc. (EDF), one of the first, and most energetic of a new kind of public interest firm. The National Audubon Society later subsidized EDF through court challenges in Michigan, and through the decisive DDT hearings in Wisconsin, the first state to ban DDT because it was adjudged an environmental contaminant.

In 1969 EDF, National Audubon Society, Sierra Club, and the West Michigan Environmental Action Council petitioned the Secretary of Agriculture to bar the use of DDT by "suspending" and "cancelling" its registration as a pesticide. The hearing process took nearly three years because our laws have traditionally favored the producer over the consumer. Unfortunately, also, the existing laws relating to chemical pesticides registration were drafted long before there was scientific awareness of the environmental hazards that some of these chemical poisons pose. The law focuses on the prevention of "imminent hazards to human life," but DDT has low toxicity for large mammals like man, whose slower metabolism (compared to birds, etc.) and detoxifying mechanisms afford some protection. Thus most of the defense of DDT has hinged on this technical point embedded in law, and most agriculturists, food producers, and their chemical suppliers have refused to enlarge their awareness to include responsibility for the environmental contamination which seriously affects many lower forms of life. They have disregarded the significant distinction between the acute and chronic or cumulative effects of their chemical tools.

Indeed, we know now that DDT, like the related PCBs (polychlorinated biphenyls used industrially), contaminates the entire biosphere at low levels, but that these minute quantities of long-lived [toxic] chemicals enter food webs and are magnified in the process of being passed from one link in the food chain to another. It has been argued, on what were thought to be conservative scientific grounds, that "research showing the effects of pesticides on fish and wildlife in the Chesapeake Bay cannot be applied to fish and wildlife generally." As I have pointed out elsewhere,[26] however, "If this is a scientific imperative the agribusiness community should be asked to apply chemicals only after a farm-by-farm study of externalities. It is true that the maximization of net returns in pesticide use of cotton requires different resource allocations in Alabama than in California, but this is so precisely because maximization is sought despite differing profit margins. On the other hand, long-lived, fat-soluble hydrocarbon insecticides tend to be magnified in food webs in both Alabama and California because the natural mechanisms responsible for this magnification of barely perceptible quantities (DDT in water, for example) to acutely toxic levels after four or five transfers through trophic levels are functionally similar (though they involve different species). The end result of this process is the maximization of biological insult, resulting in death, and is objectionable whether it happens to Connecticut's ospreys or California's western grebes, both species at the ends of contaminated food chains."

WEAK APOLOGIA

Much has already been said about the irrationalities of most DDT apologia, but it may help to dissect some of the typically extreme claims made by the several defenders of DDT under review.

Leaving aside the merely emotional criticisms, what factual questions posed by the anti-anti-DDT forces deserve attention? This must unfortunately be done in general terms because research scientists refuse to become involved with criticisms "that do not deserve scientific discussion"—criticisms that other scientists are, or should be, competent to see through for themselves. Since, however, our anti-anti-pesticides critics are scientists competent in one area who have taken it upon themselves to speak in areas quite outside their competence, someone needs to redress the balance.

Jukes wrote, "If the manufacture and export of DDT are banned in the United States, the world-wide antimalarial program will collapse [because] a ban in the United States would lead to prejudice against the use of DDT elsewhere."[27] This is partly true, but only in the sense that if the U. S. decided that DDT was not good enough for itself, this might alert the rest of the world to problems they are now insensitive to. This is why the National Audubon Society initially suggested that what was not good enough for domestic consumption should not be exported. When the World Health Organization (WHO) insisted it needed DDT for world malaria control, however, we did not press the issue, though we are currently researching the adequacy of WHO's pesticides screening program to try to establish how dependent the world is on this one chemical.

Almost all apologists for DDT have insisted[28] that environmental levels of DDT in world environments, whether in Antarctica or elsewhere, were infinitesimal and would not even be detectable except for new laboratory equipment of hypersensitive accuracy. It is perhaps true that we can detect single molecules of a foreign substance with modern equipment, but our responsibility is to ask what the effect of these molecules may be. Undetected, we might simply have an observable effect that could not be explained. What sensitive analytical devices like vapor phase chromatography and electron capture have allowed us to do is to trace back physiological effects to their source, even when a very few parts per billion in the environment may be the causal mechanism. However, "the claimed detection of DDT in Antarctic penguins at levels in the range of one part per billion"[29] actually involves contamination as high as 180 parts per billion.[30] The "magic bullet" quality of DDT[31] is an advantage only for those who disregard the development of insect resistance against this chemical and discount t other organisms who may be or indeed are affected by this sam chemical.

Jukes says of the malaria control program: "I have not mentioned cost, because this should not be a prime consideration when many human lives are at stake."[32] But we know that alternative, environmentally acceptable mosquito control chemicals are available, and that WHO does not use them because it considers them uneconomic for its particular task. Our continuing use of DDT is therefore in part an insistence on making the least dollar investment in these programs; with more willingness to share its largesse, the United States could subsidize a less environmentally destructive malaria control program and accomplish the double objective of controlling malaria and controlling environmental pollution.

AGRICULTURE

Jukes says that "Obviously a group of crop plants such as potatoes, corn, tomatoes and alfalfa, cannot be grown as a mixture."[33] This is an unthinking defense of agricultural monocultures that Cornell entomologist David Pimental[34] has shown to be false, even though he did not test the particular random combinations proposed by Jukes. Indeed, modern, intensive, technological agriculture is the happenstance result of emphasizing one factor—monetary return for the individual producer—while neglecting most others. This is what caused anthropologist Margaret Mead[35] to complain, properly, that agriculturists have become more interested in producing commodities—whatever their ultimate use—rather than producing food for people. This is also why, at least in part, we continue to have malnutrition and near-starvation in the midst of plenty.

As already suggested, Borlaug, Jukes, and White-Stevens are also victims of the myopia which affects most promoters of agriculture. A common, popular fallacy foisted on the general public by these apologists is the notion that any restriction of pesticides is tantamount to the elimination of all agricultural chemicals—pesticides and fertilizers—and threatens a return to the dark ages of civilization. Borlaug wrote, "During the long, obscure, dimly defined prehistoric period when man lived as a wandering hunter and food gatherer, chronic food shortages must have forced man to expend virtually all of his energies in struggling to feed himself, and thereby precluded him from developing a sedentary way of life."[36] How, then did man break out of these chains? The fact is, as Richard Lee and Irven DeVore[37] have shown, that primitive man's life, far from always being "nasty, brutish, and short," was economically superior to modern man's existence in the sense that the necessities of life which hunting and food gathering yield were provided in less than four days of every week, rather than the five or six that has characterized industrial man's lot. This, we may suggest, is what allowed primitive man to dream and invent a variety of civilizations on every continent he occupied.

A related fallacy is the widely publicized "fact" that modern agriculture involves only 5% of a nation's population in food production. This is so only if one erroneously accepts the notion that today's farmer is a self-sufficient producer, as he came near to being a few generations ago. Today's farmer is completely dependent on industry to provide him with the sophisticated machinery he uses, the gasoline he buys to power this machinery, the fertilizers he buys instead of produces, the pesticides he buys to try to protect the festive board his monocultures spread for various pests, and the bank loans he must have to make the heavy seasonal investments his intensive practices require. It still takes 20% to 25% of our total population to grow the food fibers that 40% of us produced 80 years ago, and that 80% of us produced during prior centuries of the agricultural revolution. The notion, expounded by Borlaug, that governments must assume a fair return on agricultural investment lest farmers be driven off their farms "and into the slums of the large cities" is particularly ironic. It is "progress" in the technology of agriculture, with government subsidies, that has so driven down prices (by multiplying productivity and investment) that marginal operators have been squeezed out of business. Our vaunted American agricultural progress was won by displacing millions of people who have been forced to congest the cities and contribute to their present decline. The "green revolution" Borlaug has helped launch, although it does promise more food, may, unless a variety of social institutions[38] are modified in time to accommodate it, end by contributing to similar socio-political and economic dislocations.

WILDLIFE

As already suggested, none of our critics—except Spencer, who has misused his talents in this area—are competent to discuss the effects of pesticides contamination on wildlife populations. This fact was made explicit on September 22, 1971 when Jukes was denied standing as an expert at the EPA hearings on DDT, since it was shown that he had done no original research on DDT or wildlife.

The fallacy of longest standing is White-Stevens' insistence that Audubon Christmas Count data show an increase in robin populations. What this chemist-turned-ornithologist failed to notice, or refused to accept, is that there are more participants now, and that growing competition among participants has caused them to work harder and otherwise to perfect their skills at finding, identifying and counting birds. From year to year, therefore, the improvement has rendered the counts unreliable for comparisons of total numbers reported, though they have become better clues to the occurrence and distribution of species.

The robin is among the most widely dispersed summer resident birds of the continent, and therefore among the numerically most abundant species we have. It nests in every state and every province of the U. S. and Canada, with nesting densities increasing as one moves northward from the southern tier of states. We do not know, however, where its greatest wintering densities are, though we know that some unmeasured fraction of the total population winters in Mexico. The Audubon Christmas Counts would be helpful in mapping the areas of highest winter densities in the U. S., but no one has as yet done this. We do know, however, that the highest density of Audubon Christmas Counts, being in the northeastern U. S., does not correspond to the area of highest distribution of winter robins, since these birds are then mostly farther south. Aside from these problems, it is likely that our count circles assess too small a sample of the winter habitats of the robin to be a reliable index to the total population.

To complicate matters, winter robins tend to flock together in sizeable roosts, and these roosts may shift from one place to another in succeeding winters. One winter the roost will be inside the 15-mile diameter area of an Audubon Christmas Count, another winter outside. The numbers of robins *reported* may thus fluctuate considerably on the basis of this mere happenstance, not on the basis of changes in their total numbers. The robin counts recorded at Nashville, Tennessee (Fig. 1) illustrates this

FIGURE 1

Robins recorded in Nashville, Tenn., Audubon Christmas Count (from *American Birds* and its precursor, *Audubon Field Notes*).

1952 (53rd Count)	1100 robins
1953	4000
1954	541
1955	143
1956	3600
1957	355
1958	5000
1959	37
1960	800,000
1961	11
1962	500,000
1963	162
1964	1500
1965	91
1966	33
1967	9562
1968	32
1969	3100
1970	7
1971	500,000

well, and shows why the crude summations of Audubon Christmas Count data used by White-Stevens, Jukes, Marvin, and others to justify their claims that birds have increased in number are invalid.

No ornithologist has ever used these data to claim bird species increases, nor has the National Audubon Society ever used them to back a claim that one species or another had declined in numbers. We know better.

The bald eagle, our national bird, is one of those species at the end of a long food chain (it is a fish-eater) that has suffered seriously from DDT pollution. The National Audubon Society has been involved in a nine-year cooperative research and conservation project with the Bureau of Sport Fisheries and Wildlife, Forest Service, National Park Service, and scores of other agency, university, and private field biologists, and is now preparing various aspects of this field and laboratory material for publication. The most significant result of this work is the demonstration of a direct relationship between DDT (and DDE) body burdens and reproductive success. The higher the burden, the less success, largely because thin eggshells prevent successful incubation. This, as one would expect, is a regional phenomenon, so that those eagles lucky enough to nest and winter in less contaminated environments continue to produce some young.

The osprey is a large fish-eating hawk, and as such is an ecological parallel to the bald eagle in food habits. It has suffered equally from DDT poisoning, exhibiting the same thin eggshell syndrome, etc. One of the most impressive documentations of the relationship between high DDT burdens and low reproductive success is illustrated by the relation between Chesapeake Bay and Connecticut osprey populations. Chesapeake Bay has lower DDT levels and its ospreys reproduce much better than those of Connecticut, where DDT contamination is high. When the eggs of Chesapeake Bay birds are transplanted to Connecticut nests, they hatch at the same rate as they would have if left in their own nests, whereas Connecticut eggs fail at the same rate in Chesapeake Bay nests as they would have if left in their own nests. The failure to hatch and produce viable young is thus a result either of DDT burdens or genetic defect. But we know from a long series of experiments that DDT burdens are a sufficient cause of failure, and there are no other apparent malfunctions in Connecticut osprey populations. We also know that dieldrin is itself a sufficient cause of hatching failure when present in eggs in sufficient amounts, but the thin eggshell syndrome's relation to DDE is already fully demonstrated scientifically, and is not dependent on dieldrin, mercury, PCBs or other contaminants, despite frequent smoke-screen tactics to the contrary by DDT's apologists.

Although at least a dozen American bird species are now known to suffer from the thin eggshell syndrome, it will suffice to treat only two more, the peregrine falcon and the brown pelican, which have been subjected to reanalysis by Jukes and Edwards. Like Spencer, Jukes and Edwards have succeeded in obfuscating the issues by recourse to "skillfully-prepared document(s) of a familiar kind." They cite authorities, or their works, but fail to tell their readers that the conclusions they present are diametrically opposed to the conclusions reached by the scientists who did the research.

Jukes, for example, refers to the authority on peregrine falcon populations, Dr. J. J. Hickey, but discounts Hickey's conclusions that the peregrine decline is an extraordinary biological event, and not due to the usual human pressures that have caused a gradual decline in most American wildlife populations since white men began taking over the continent for themselves. Jukes seems to accept[39] the documented fact that the peregrine is no longer breeding in the eastern United States, but then introduces evidence alleged to counter this claim: "However, the counts of migrant peregrines at Hawk Mountain, Pennsylvania, were as follows. . ." The reader must be alert enough to recognize that a bird may no longer breed in the eastern United States, and yet may migrate past Hawk Mountain in those same eastern United States, since the migrants originate in northern Canada. Hawk Mountain data are therefore no clue to the status of eastern U. S. peregrines. Nor is the fact that they have always been rare compared to other species of any significance in evaluating whether or not they are now being affected by DDT. Jukes also conveniently ignores the implications of the fact that the Madison, Wisconsin peregrine conference organized by and reported upon by Dr. Hickey[40] was a search for hypotheses to account for the catastrophic collapse of the peregrine population of the eastern United States. The editorial task turned out to be a monumental one, had to be done as an extracurricular chore by Professor Hickey, and therefore the book appeared three years after the conference was held. This allowed the editor to update our understanding of the decline of the peregrine in a summary essay. But it is noteworthy that Jukes quotes the preliminary views of the conference participants (Herbert and Fyfe), but not the man who had meanwhile done so much thinking about the implications of the original data. Instead he quotes a 1942 paper of Hickey's and leaves out more recent work by Cade[11] that shows that Canadian peregrine populations, too, are in trouble.

Instead of merely putting his own amateur interpretation on the works of experts in fields other than his own, J. Gordon Edwards actually attacks the methodology, the conclusions, and even the motives of these experts. Edwards devoted seven tight-packed pages of his Congressional testimony to the brown pelican, accusing biologists of the California Fish & Game Department and the U.S. Bureau of Sports Fisheries and Wildlife of "scientific persecution" of brown pelicans using or trying to use Anacapa Island off the California Coast as a nesting site. He ends a five-page typescript entitled *The Truth about the California Brown Pelicans* (late 1971) with an anguished "When will the public and the press become aware of the untruthful nature of the environmentalists' propaganda?"

It may be true that the status of the west coast's brown pelicans has not been clarified by a series of partial observations reported upon by various writers. A suspicious critic can therefore have a field day juxtaposing seeming contradictions if he overlooks or disregards that these seeming contradictions are probably results of different observational opportunities, oversight, or simply different objectives in observation. This is exactly why the California Department of Fish and Game and the U.S. Bureau of Sports Fisheries and Wildlife, intent on learning what factors affect these birds, have both instituted long-term studies. The principal students, Franklin Gress for the state agency and Daniel W. Anderson for the federal bureau, were both selected because they had already demonstrated competence in this area. Edwards' disingenuous criticisms have fortunately not caused responsible agency officials to change their minds about the competence of these field men.

Meanwhile, though he would have preferred publishing when his field study was complete, Edwards' political treatment of the issue of DDT's effects on pelicans led Dr. Anderson to publish a November 30, 1971 interim report, *The 1971 Status of California Brown Pelicans*. This report, which will be accepted as indicative by most of the scientific community until a more detailed summary of data is submitted for formal criticism, says that "Continued sampling for pesticide residues in Gulf of California browns (pelicans) substantiated past studies by these and other researchers in showing an inverse relationship between thin-shelled eggs and egg-index-residues of p,p'-DDE. Thin-shelled eggs and resultant breakages were a major cause of nest abandonments and reduced clutch sizes in 1970 and to a lesser degree in 1971."

Jukes wrote "As a means of arousing alarm concerning DDT, the EDF and the National Audubon Society have both stated that DDT causes cancer. The implication that DDT in breast milk may cause cancer in babies is superlatively sensational copy."[42] It is not true that the National Audubon Society has told people that DDT causes cancer in man. We have raised the question, however, because it is a question many experts are properly concerned about. All rational students of this problem agree that there is no *proof* that DDT causes cancer in man; that such causation, if it does occur, is at low levels; and that, conversely, there is no *proof* that DDT does *not* cause cancer in man. The failure to find evidence is much too often taken to indicate that there is none to be found. Many apologists for DDT are guilty of obfuscating this issue. A recent summary statement of this complex problem was made by cancer specialist Dr. Samuel Epstein, who stated at EPA's DDT hearings that "DDT has been shown to be carcinogenic (to mice) in a series of well-designed experiments on the basis of standard toxicological carcinogenesis procedure and philosophy. We have no reason to exclude the fact that DDT represents a significant carcinogenic hazard to man."

THE HUMAN DILEMMA

The 25-year pesticide controversy is clear evidence of a serious failure of our social institutions to guide the application of modern technology. The attitude of many chemical company officials during this controversy has demonstrated the more vicious side of the private capitalism that dominates our economy. The destructive side effects of the use of many of our present armory of chemical pesticides were little known, and little questioned, when this technological response to insect pest problems was instituted. Some chemical pesticides have, of course, been in use for a long time, but the synthetic chemical technology discussed here dates from World War II only. Given the heavy policy and fiscal investments in this pest control approach, the first response to the challenge involved in wildlife mortality—especially since this was at first brought to light by "birdwatchers"—was to deny the problem and to make countercharges of emotionalism. Except for the handful of incompetent or dishonest defenses of DDT outlined in this article, however, the principal roadblock to eliminating the contamination of DDT use is now two-fold: first, a narrow positivism exists which focuses on imminent hazards to man and discounts wildlife losses as minor or irrelevant; and second, we tend to believe ourselves so dependent on DDT in agriculture and public health that wildlife losses are labeled a necessary price for the production and protection we value more.

All present chemical approaches to insect pest control are doomed to failure because insect populations are versatile enough to develop resistance through evolutionary adaptation to the new chemical parameters we impose on their environments. DDT has already become ineffective against more than 200 insect species. Its use in the United States, mostly in cotton growing, was obviously self-limiting even before EPA's 1972 ban. Tragically, the obdurate insistence on using it to the bitter end of its effectiveness—mostly for private pecuniary advantage and in disregard of the social costs it imposes—has poisoned the world and impoverished the world's fauna. This has happened at the very time when western man, having solved most production problems, is again turning to the enjoyment of Nature's diversified biota to help balance his increasingly boring artificial existence. Having escaped the struggle for existence involved in material scarcity, he is rediscovering that he is still part of Nature, and that he is a part of Nature aware of himself, and thus trustee for all continuing evolution.

The proximate problems of the technologically less advanced Third World—like those of ghetto blacks, American Indians, Mexicans, and Puerto Ricans in the United States—are of course very different. Their's is still the task of filling the belly. This is perhaps a problem of overconsumption by the "haves," and underconsumption by the "have nots;" it is certainly the dilemma of world overpopulation based on low natural resources carrying capacity and poor social organization.

Ironically, and most tragically, it turns out that the new dependence of the Third World on DDT now poses a cruel dilemma which has been completely ignored by the DDT apologists. The World Health Organization has announced[43] that unless DDT use in world agriculture is soon phased out, malaria control programs will become increasingly ineffective because the malaria vectors—mostly Anopheline mosquitoes—are developing resistance to DDT faster than WHO's public health programs can break the fatal links between human malaria reservoirs and new human victims. WHO claims that DDT allowed it to remove or greatly reduce the threat of malaria for a billion people in the last 25 years. But since the resulting population growth spurt imposes new food production requirements, DDT—because it was cheaper than other pesticides and at first effective against a broader range of insect pests—was pressed into extensive use in agriculture.

Unfortunately, food production has not caught up with population growth, though decade after decade the professional optimists have promised that success was just around the corner. After nearly thirty years of this struggle, the WHO and FAO together have brought the number of people at the verge of starvation to 1.3 billion. The WHO malaria control programs are now jeopardized, not, as our critics claim, because environmentalists insist DDT should be banned in the U. S., but rather because DDT continues to be used in Third World agriculture. This has happened because two groups of experts have failed to coordinate their programs so as to avoid conflict, and each now claims to be dependent on the continuing use of a pesticide whose effectiveness is destroyed by its own use.

FOOTNOTES

[*] Staff Biologist and Vice President, National Audubon Society, New York.

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[24] National Academy of Sciences—National Research Council, Pest Control and Wildlife Relationships (Wash. D.C.: Publications 920-A, 920-B, 920-C, 1962, 1963); Egler, F. E., *Pesticides and the National Academy of Sciences*, Atlantic Naturalist (Oct.-Dec. 1962, Oct.-Dec. 1963).

[25] Chemists are today's most narrowly positivistic scientists, and as such have had difficulty accepting the much more dynamic view of the reality of ecosystem contamination presented by ecologists and other outdoor-oriented scientists. I use the word positivistic not in terms of scientific reductionism, which is a necessary methodology, but to describe that unphilosophic attitude which causes so much learning to deteriorate to a conservative absolutism on one hand, or to a cynical relativism on the other. It was this positivist's option A. N. Whitehead warned about, as paraphrased by Ralph V. Norman, Jr.: "The positivist, too modest to go searching for connections that have not appeared, simply states what he sees and only what he sees. But there is arrogance in such modesty; its rigid assumption is that we know already what system is. What our systems cannot organize, nothing can organize." Norman, R. V. Jr., *Whitehead and Mathematicism*, in Kline, G. L., ed., Alfred North Whitehead: Essays on His Philosophy (Prentice-Hall, 1963). Yale biologist Edward S. Deevey once pointed out that "The naive and mischievous notion that biology is reducible to chemistry is held by many chemists, a few biologists, and an inordinate number of college deans." All positivists have overlooked the hierarchical organization of reality, and we are victimized by a lingering typological outlook, an inheritance of two thousand years of "special creation" assumptions not yet destroyed by Darwin's vision of a continuing organic evolution. G. G. Simpson showed that the physical sciences deal in "types of things" (atoms, molecules) and are thus typological; but that when life enters, every organism and every population (every ecosystem) has a history that continually modifies it and makes it unique. The exact replication of experimental reactions which the chemist considers his test of truth becomes only generally recognizable as trend or experience where unique things, rather than types of things, are involved. Simpson, G. G., *Biology and the Public Good*, American Scientist, 55:2 (June 1967).

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[32] *Id.,* at 540.

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RUTGERS UNIVERSITY *The State University of New Jersey*

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August 8, 1972

Mr. John C. Devlin
News Room
New York Times
229 W. 43rd Street
New York, N. Y. 10036

Dear Mr. Devlin:

I enjoyed our 'phone conversation on Friday, 4 August, relative to the actual facts concerning the use and impact of pesticides in the environment.

You asked as to where is all the supportive evidence to justify the continued use of the more persistent pesticides such as the metal-organics (mercury) and organo chlorines (as DDT). The scientific literature on these compounds is simply voluminous, running into at least 100,000 titles published over the past 35-40 years in some two dozen countries. The literature on DDT alone exceeds 20,000 published papers. Dr. Gordon Edwards has prepared a bibliography of over 150 papers on the degradation, both physical, chemical and biological, of DDT in the environment. Yet we see repeatedly reiterated in the lay press, including the New York Times that DDT and its analogues are virtually indestructible and that some 90% of all the DDT ever manufactured over the past 35 years and released into the environment is still there, rattling around to the detriment of the biosphere. Such hyperbolic statements serve only to arouse public consternation, for factually they are not only nonsense but totally erroneous.

The alleged impact of DDT et al on the reproduction of mammals, avians and fish applies only to artifactual laboratory experiments where inordinate doses were applied under stress conditions and often by routes of administration quite unrelated to normal exposures in the field. The annual census reports of USDI, Fish and Wildlife Bureau, reveal that over the past 30 years favored wildlife of all kinds has substantially increased. There is not one shred of evidence that registered pesticides correctly applied in accordance with approved label recommendations have significantly contributed to the decline or extinction of one single species other than insects - e.g., Anopheline mosquito vectors of malaria, blood sucking flies, and many other vectors of human and animal diseases and destroyers of edible, ornamental and forest crops.

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Defendant Aububon Exhibit Z

I suggest you contact for further definitive details as to the impact of pesticides on cancer in humans (Jukes, Roan, Ottoboni, Hayes), on avian reproduction, particularly the eggshell thinning myth (Edwards, Switzer), on public health (Hayes, Schoof, Still), on toxicology (Lykken, Hayes), on crop protection (Metcalf, Reynolds, Kriner, Chapman, Knipling, Newsome, Guyer, Eden) and on degradation and residues (Lichtenstein, Edwards, Lisk). I list the addresses of these scientists.

In accord with your request, I enclose some of my own publications which discuss in expository terms for the layman some of these technical matters.

Finally I will be glad to prepare an article for the Magazine Section of the Sunday New York Times, or a short Op Ed statement for your consideration and that of Mr. Harrison Salisbury.

I hope this information will aid you in disentangling the web of misinformation and to clarify the picture.

Yours sincerely,

Robert White-Stevens

Robert H. White-Stevens
Chairman

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Attach. - 1
Enclosures - 8

World Food Production Potential
Into the Future with Agricultural Chemicals
Pan Am "Clipper" article
The Role of Pesticides in Food Production and Health
The Facts and Fallacies of SILENT SPRING
The Role of Agricultural Chemicals in Feeding
   an Exploding Population
The contribution of the Farmer to the Environment
The Ecological and Environmental Effects of Agronomic Chemicals

Names and Addresses of Selected Pesticide Authorities

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NOTE: There are, of course, many dozens of other scientists thoroughly familiar with the chemistry, biological activity, toxicology, ecology and fate of pesticidal compounds in the field, but these will serve as a starter. Should you require additional names and addresses just call me and I'll be glad to supply them.

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WORLD FOOD PRODUCTION POTENTIAL

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INTRODUCTION

There is no matter of greater concern to responsible agricultural and food scientists today than the rapidly approaching fulfillment of the prophesy of Thomas Malthus, made nearly two centuries ago, that mankind will eventually increase his numbers beyond the limits of his food supply. Conferences such as this are now being held all over the western world with increasing frequency to consider the implications of this ominous prospect, and to develop, hopefully, some rational, practical and realistic program to meet and obviate the human suffering and socio-political breakdown which is now inexorably approaching.

Such colloquies are most important and very essential at this time for among the food-affluent western world impending world food deficiencies are obscured, in the minds of the majority, by impressions of mountainous food surpluses, which though now largely dissipated, are still vivid to the United States taxpayer; while in the underdeveloped, overpopulated nations of Asia, Africa and Latin America hunger is so omnipresent and enveloping that the great mass of undernourished peoples struggle aimlessly and futilely against a shrinking food supply, without any real awareness of the impending calamity which encroaches daily upon them.

Major Immediate Steps by West Imperative

To alert the public, particularly the intelligent, taxpaying people in the western countries, of the unparalleled gravity inherent in a world population increase of 2.2% per annum (doubling time 31.9 years) is obviously the first order of business. It is imperative that vast sums of money, millions of man-years of knowledge and effort and extensive inputs of supplies, animal and plant stocks, chemicals and equipment both direct for and ancillary to birth control and food production must be invested immediately merely to hold the status of nutrition at its present lower than subsistence level.

Were this to be carried out right now, on a virtually worldwide scale through the integrated and collaborative efforts of the FAO and WHO of the United Nations, and the World Bank, together with the major developed nations including the USSR, France, England, Germany, Scandanavia, Canada, Australia and South Africa in addition to the United States and including the various private organizations such as the churches, the Rockefeller, Ford and other Foundations, for the purpose of applying modern scientific agriculture realistically, there is every reason to believe a finger can be held in the dyke and socio-political chaos stemmed at least through year 2000.

Worldwide Starvation Inevitable

The probability, however, that such a concerted effort by all the developed nations and their various public and private organizations is both unlikely and unrealistic has led the Paddock brothers to predict in their recent analysis of world population and food

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supply (Famine, 1975) that despite all the well-intentioned talk and solemn pronunciamentos from high offices the decade of the 1970's will be recorded in history as "the time of famines." They predict humans will perish from starvation across vast reaches of the earth in the 1970's on a scale unparalleled in history. Scholars, knowledgeable in demography and world agriculture, are now virtually reconciled to a death rate as high as 50 million per annum, a level tenfold the present, which may extend for twenty or more years before it subsides or civilization as we know it recedes into oblivion.

This is not a prediction or speculation of "the shape of things to come," in the remote mists of the future; it has already begun, and is gathering momentum in every passing hour. The most shameful and remorseful aspect of the present situation is the fact that today in this country where Providence has bestowed upon us the greatest affluence any nation has ever known, over 10 million Americans, 5% of our population, are in a state approaching starvation.

Hunger in the Midst of Plenty

This is the epitome of the paradox of plenty. For it is in this century that mankind has reached the threshold when, for the first time in history, it has actually become possible to banish hunger and want from the earth. In one hundred years we in America have advanced agriculture, through education, extension, research and development, further than it had progressed in ten thousand years. This has been the great and singular contribution of the land grant college and experiment station system in concert with industry and the farmer not only to the benefit of the American people but to all the nations of the earth.

The question before all of us whose training and experience in agriculture which bestows upon us also the responsibility to provide "bread for the table of humanity," was raised by Senator McGovern:

> "Shall we in America be remembered in the history of our times as the nation that preferred to expend their talents, their treasure and their opportunities upon sending a man to the moon, rather than turning our knowledge, our power and our compassion upon the needs of mankind?"

There can be no concern of modern educated man more relevant than this, the relief of hunger and destitution among his fellow men. Failure for us to appreciate and to act upon this responsibility will indubitably result in all the other great works of man achieved in our time becoming both futile and sterile. There can be little accomplishment in coursing the outer reaches of space if to do so we must allow human society on earth to decay. Our civilization is at stake and it can just as readily descend into oblivion as did that of Egypt, Greece, and Rome before us.

The basic problem has been succinctly stated by Robert Hutchings: "We have more information and ability and less human understanding than at any time in man's history !"

The paradox lies in the fact that today human hunger is totally unnecessary. For agricultural science and its ancillary disciplines, can, with its present knowledge and tools, literally banish hunger from the earth in our time. There may never be another opportunity for man to achieve this, for failure to do so now can lead us to the point where the overwhelming pressures of a burgeoning human population will so disrupt our organization and confidence that we too will be reduced to the day-to-day, hand-to-mouth existence which prevails among over half the people of the earth today.

World Food Needs Now and by Year 2000

The questions we need to ask ourselves now and also to provide the answers and to develop a worldwide program immediately, without further argument or delay, are:

(i) What is the extent of the food gap today on a global and regional basis?

(ii) What are the critical foods?

(iii) What are the needs of the next 35 years?

(iv) Can conventional agriculture meet these needs?

(v) Can unconventional food production supplement these needs?

(vi) What form of unconventional food production would be the most economically practical and effective?

Although 65% of the present world population is malnourished by the minimum daily requirement standards published by the World Health Organization (WHO) of the United Nations, the total annual world food gap is estimated by the Foreign Research Service of the United States Department of Agriculture at not more than 5%. This relatively low figure, however, is quite misleading as it does not delineate the enormously uneven distribution of foods among the various nations, and it also ignores the stupendous loss of food between harvest to the consumer's plate, estimated in India, for example, as in excess of 50%. It also does not indicate the extent of the gap among critical foodstuffs, particularly proteins and vitamins.

The facts derived from the Third World Food Survey of the Food and Agricultural Organization of the United Nations indicate:

(i) The food gap between the peoples of the developed and underdeveloped countries has widened increasingly since World War II;

(ii) At least 25% of the total world population (800 million) is now seriously undernourished (marasmus), and another 40% (1,280 million) is malnourished, reducing child growth, work ability, health and lifespan of the people;

(iii) Animal protein consumption in the underdeveloped countries is less than 20% of the daily intake in the developed countries; e.g., India's is less than 10% of the United States';

(iv) Peoples in underdeveloped countries derive over 80% of their calories from poor-quality starches-- roots, tubers, etc.;

(v) Regionally, at the present time Europe and Russia, Oceania (Australia, New Zealand and some South Pacific isles), the United States and Canada, and isolated pockets in Africa (Union of South Africa, Rhodesia) and South America (Argentina) are, on average, free of significant malnutrition; but virtually all of oriental Asia (except Japan and South Korea), Asia Minor (except for Israel), the bulk of Africa and most of the countries in South and Central America are malnourished. On average, South America and Africa are 6% deficient, while Asia Minor is 3%, Communist China, 25% and Free Asia (India, Indonesia, etc.) over 60% deficient in minimal diet standards.

Extrapolating present deficits against the inexorable population increase, food production must be doubled merely to maintain present inadequate levels, trebled to bring all diets above the absolute minimum established by WHO, while among the underdeveloped nations where deficiencies are seriously acute now, total food production must be quadrupled and animal proteins, in particular, increased sixfold to meet demand by 2000.

The Nature of the Food Gap

Expressed as food equivalents, the present world deficit is estimated at:

30 - 35 million metric tons of wheat;
3 - 5 million metric tons of vegetable oils;
2 million metric tons of non-fat dry milk;
1/2 million metric tons of beans and peas.

This, by our standards, is by no means an insuperable deficiency. It is one the United States, Canada and Australia could meet relatively easily with the present lands and capital inputs available. However, efforts to fill these nutritional gaps from surplus U.S. stocks of milk, pulses, oils and cereals have been beset with uncertainty, mishandling, malfeasance and corruption in certain areas and have generated political antipathy and public apathy rather than gratitude and encouragement among many hungry peoples. Now our surpluses are virtually exhausted and, at present, there appears to be little interest or encouragement in Congress or the Administration to rebuild them. In addition, we in the United States, the Canadians, the Australians and most of the western Europeans, preferring a preponderantly meat diet to a vegetable regimen, consume vast quantities of cereals and vegetable proteins in animal feeds, converting plant protein and energy at a 7:1 loss into high-quality animal protein.

In the United States and Canada we even import large quantities of animal proteins (e.g., fish meal) from countries (e.g., Peru) desperately in need of these proteins for their children. This weird twist in international economics induces these protein-hungry countries to trade the health and growth of their own children for hard currency. These animal proteins, rich in essential amino acids as they are, go into livestock feeds, for poultry and swine, merely to make a more desirable protein food for our affluence, but at a 7:1 loss in efficiency.

The critical foods are: first, protein; second, vitamins; third, oils and fats; and fourth, carbohydrates.

Among the proteins, animal protein is the most deficient, and primarily the essential amino acids, methionine, lysine, tryptophane and threonine. The relative animal protein available to the various areas of the world reveals the immense maldistribution of this essential food: Oceania, 130 gms./cap./day; North America, 76 g.; Europe, 33 g.; South America, 26 g.; Africa, 9 g. and Asia, 2 g. As the minimum daily requirement for animal protein is set at 10 g. per day, Asia and Africa are, overall, already below the minimum, and South America can be expected to follow before 1980.

At the present time maldistribution, aggravated by politics, economics, local transportation and storage, is the main problem, for there is right now sufficient animal protein in the world to provide 20 gms./cap./day, or twice the minimum requirement, for every man, woman and child on earth.

Animal protein deficiency is further aggravated in a number of countries by religious dogma, traditional mores and ancient customs, the origins of which are usually unknown and forgotten in the mists of antiquity. For today all over the world, particularly among underdeveloped nations that can least afford such superstitious luxury, absurd obeisance is made to ridiculous dietary restrictions which perpetuate misery and suffering, and which contribute essentially nothing to the welfare of the people. In India, for example, there are some 250 million head of cattle, more than we have in the United States, which unrestrainedly browse among the crops and pastures, devouring desperately needed foods. It is both unlawful and sacrilegious to slaughter and devour these beasts, yet meanwhile, millions of Indian children suffer from Kwashiorkor. The cows are milked, but the milk yields are a joke, about 400 - 500 pounds per lactation, compared to 10 to 20,000 pounds in western Europe and North America.

In all fairness, however, it should be noted that the only general farm traction in India is bullock power; and without cows there would, of course, be no bullocks. However, the numbers could and indeed must be curtailed or the whole country will literally go to the cows. Actually, a well-planned breeding nutrition and parasite control program designed to produce good traction stock combined with high milk yields, ignoring the meat factor completely, would be a logical step to the reduction of the very serious protein hunger in India today.

The vitamin deficiencies present in the world are really of minor importance so far as production is concerned, for we have learned in the United States and Europe, over the past 25 years, how to produce all the vitamins, by synthesis and fermentation, that are required by man or his domestic livestock. Today in the United States over $25 million worth of man-made vitamins are distributed as animal feed additives annually. We can, without a doubt, meet all the vitamin requirements through year 2000 and far beyond for both man and beast alike, with the available facilities and capital inputs in the developed western countries.

Fats and oils are also in current surplus supply in the western world and appear to be likely so to continue for at least another 20 years. Again, maldistribution is the major problem, rather than supply, for there are still vast numbers of people who are deficient in dietary fats.

Carbohydrates, although abundant on a total basis now, may well become seriously limited in many areas within a decade. The major source will continue to be grain, rather than roots, tubers and sugarcane.

Grain Production: The Basic Food Indicator

The curve of total world grain production was ominously crossed by that of world consumption in 1960; and unless immediate measures are taken to turn the production of cereals sharply upward, the resulting stock "drawdown" will convert the recent burden of surplus grain in North America, so maligned in the 1950's, into a worldwide total deficit by 1970.

Grain now, as it has been since agriculture began, is the basis of all food production; and the balance of supply and demand of grain is reflected in the availability of all foods everywhere. It is, perhaps, the most sensitive indicator to the total relation of population and food supply. In Europe over the past decade, grain production has increased over twice as rapidly as has the population (2 1/2% per annum versus 1%, respectively). This is substantial progress and is reflected in the current munificent European economy. In Latin America, however, although grain production also rose 2 1/2% annum a surprising achievement, the population increased more sharply with the result that South American economy is declining rapidly and widespread hunger is ominously approaching.

In contrast to this bleak Malthusian prospect in South America, Mexico, a country which was rapidly approaching a food: population crisis only a dozen years ago, has, with Rockefeller Foundation and USDA technical help, achieved a remarkable reversal in its grain: people ratio. Through expert adaptive breeding of strains of wheat, maize and sorghum to specific subtropical environments, through appropriate fertilizer and soil amendments, through cautiously metered weed, insect and disease control, Mexico has become the major subtropical wheat producer in the world and is now actually exporting grain. In addition and more importantly, its heat-drouth-adapted wheat strains are serving as a seed stock source for India (18,000 tons), Turkey (19,600 tons) and Pakistan (40,000 tons). This very practical and largely unacclaimed program is perhaps the most outstanding example of conventional agricultural science applied to food production in submarginal countries on a pragmatic and integrated basis. The effect of this imaginative but practical program is now reflected in the astonishing but welcome bumper yields of grain (over 105 million metric tons) for 1968 in India.

North America (United States, Canada, Mexico) is the only major grain-exporting area in the world today, and it would behoove us to quit fooling around with grain allotments and curtailed acreage and to raise all the grain we can while we yet have the time and facilities to do so. We are the last great hope on earth to stem the tide of onrushing hunger until these backward countries mount their own agricultural programs, and restrain their own population growth.

Almost 3,000 years ago Joseph, in Egypt, foreseeing famine, piled up surplus grain against seven lean years and he has been accorded the wisdom of the ages for having so done. Today we do not have sufficient grain to feed our own nation for seven lean months, and if spread around the world, it probably would not go further than seven weeks.

If, instead of spending our substance on such exorbitantly costly projects as space exploration, we encouraged and paid our farmers to grow grain as hard as they can until every possible storage facility and additional capacity to boot was filled to the brim, it would not only provide greater security for the nation but would also give us the most powerful international weapon possible--food. We need a project Ceres far more than a project Apollo. It would, for example, be a far better security for mankind to have a 10-year supply of grain stored in Antarctica, than to land a man on the moon.

Agricultural Science More Valid than Food Gifts

It would be neither possible nor desirable for North America to attempt to feed the world forever. Apart from the fact that it simply could not be done, such a program would merely pauperize the receiving nations into helplessness and hopelessness. They must be taught to produce food for themselves with their own resources, using the techniques, equipment and plant and animal stocks of modern agriculture. They cannot use, in most cases, the methods we employ in the United States today; for they are too complex, too capitalized and based upon too advanced an agricultural technology. They need the type of agricultural practice employed in this country in the latter part of the nineteenth century, tended and guided by an indigenous extension, educational and field research and development program aimed essentially at the solution of local practical problems.

They need their own agricultural land grant colleges, their own research and demonstration farms and their own students trained for their own indigenous applied agriculture at home. There is little point in bringing their young men and women here to learn our sophisticated and advanced techniques, for when they return to their native countries most of what they have learned cannot be applied for lack of facilities, knowledge or even interest among the farmers in their homelands.

In the meantime, until these developing countries can be brought to the "take off" stage, they must be sustained with sufficient food;

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and the western world is the only hope on earth available. For starving people are apathetic; they lack energy and cannot work productively or effectively; without work no products are produced and no products yield no income; without income capital investment is futile and without capital no start on the problem can be initiated.

With basic nourishment, simple education, elementary literacy-- they can be put to work, first to produce their own needs in food, fiber and shelter, then to earn real income in goods and services, which they can exchange for currency and other products from abroad. They then will kindle new wants, expanded desires, broader markets which industry in the developed nations can supply, until they too create their own industries; and the vicious cycle of hunger, despair and want will subside and the "take off" stage will be achieved. Apart from the humanitarian aspect, such a program constitutes the greatest opportunity western industry has ever had.

Can these enviable goals be reached in India, Brazil, the Congo, Egypt, Indonesia, and host of underdeveloped countries before their onrushing population overwhelms them in a wave of destitution? There may be those who would write off such desperate nations as beyond the point of no return, but this is the council of despair and those of us whose business it is to maintain and advance agricultural science in the western world can and must materially assist in the promotion of food production in these backward and struggling lands.

There are three outstanding examples of success before us now: Mexico, Japan and Israel. The technological advances in these three countries in the past two decades have been phenomenal; and with similar attention to local problems in Asia, in Africa and in South America, the same results can unquestionably be achieved there too.

The cost of such a program, primarily as capital inputs, will be prodigious, probably in excess of $10 billion/year for over 20 years.

However, such a sum of $200 billion over 20 years to bring the hungry nations of the world out of the darkness of chaos into the light of productive development is not an excessive price to pay for the civilized nations to preserve their present relative affluence. The United States alone has expended over $122 billion since 1945 in rebuilding war-injured nations, not including the expense of the Korean and Vietnam actions, which bring the bill to well over $200 billion.

Furthermore, if the western developed nations will provide private investment industry with insurance, through the World Bank, against expropriation, confiscatory taxes or licenses and overriding management, then private industry will move into the problem and resolve it with its customary efficacy. Many western companies realize that although early returns on such investments are likely to be meagre and uncertain, as these underdeveloped nations reach the "take off" stage and begin to operate the expanding markets thus generated are extremely attractive.

On this basis private industry could easily invest $10 billion annually among these developing nations and would ultimately be well rewarded for so doing.

WORLD FOOD POTENTIALS VIA CONVENTIONAL AGRICULTURE

The areas of agricultural science which need to be extended and expanded among the developing nations to achieve world food potentials by conventional methods are:

i Crop plant and livestock improvement
ii Soil and water management
iii Agricultural engineering and mechanical equipment
iv Agricultural chemicals.

Crop Plant and Livestock Improvement

Enormous advances can be achieved within a decade through extension and expansion of the Rockefeller Foundation and Ford Foundation programs in adaptive selection and breeding of cereals such as wheat, rye, oats, barley, maize, sorghum, rice and millet to specific areas among the developing nations. This has already been achieved with the Mexican wheats, the new maize and sorghums and the International Rice Institute (I.R.I.) improved strains of rice bred in the Philippines. These new adapted strains are now moving out into suitably productive areas around the world and are yielding phenomenal harvests. When such highly productive strains are combined with high-protein qualities such as the new high lysine, tryptophane, threonine maize, Opaque Q, from Purdue University, the full impact of these genetic achievements will prove highly significant.

The development of hybrid stocks of both plants and animals adapted to specific areas can increase potential food production in both quantity and quality by a factor of from 2-to 5-fold.

Furthermore, the potential of soil and water management, mechanical equipment and of agricultural chemicals, cannot be fully realized unless the genetic capacity of the crop plants or livestock is developed to yield optimum response.

The fields of plant and animal breeding offer vast horizons for the improvement of production efficiency of plant and animal foods. The I.R,I. has already accumulated a library of rice germ plasm constituting over 10,000 strains. Such inventories could and should be assembled for every important food crop and domestic livestock known to man. In addition, examination of new crop plants and alternative livestock animals should be initiated to assess their possible potentials as food sources.

Among the plants, there are many grasses, tuberous, and fruiting plants as well as innumerable aquatic plants and microflora such as algae, which have never been seriously investigated as food sources for man and his livestock.

Among the mammals and avians there are many species for possible new food sources, the dolphin, the nutrea, eland, capybara, the manatee, the quail, the partridge, for example, and a number of familiar species which are employed for food only occasionally and in limited regions such as the rabbit, the guinea pig, the goat, the musk ox, the llama and several others consumed by man over the centuries as a source of animal protein.

Suitable aquatic species, both vertebrate and molusc, which could be cultivated in ocean, brackish and inland fresh waters are legion and constitute a great potential source of animal protein that remains virtually untapped.

Soil and Water Management

It has been characteristic of man in all climes and all times to be profligate with his available soil and water, particularly when they were in abundance. Many peoples learned the evil consequences of erosion before it became completely fatal and turned in time to terrace farming, contour planting and water - soil conservancy. Others either moved on to plunder and exploit other lands, or slowly degenerated with their soil until their culture and their people became obliterated.

The ruins of quite advanced civilizations in Central and South America, in Asia Minor, northern Africa, and southeastern Europe stand amid the eroded lands, which once sustained them, as mute evidence of the inevitable fall of man when his food and water supply declined to critical levels.

Modern scientific strip farming, contour cultivation, crop rotations and soil and water management applied among the underdeveloped nations can materially increase their food productivity and more importantly extend such productive capacity indefinitely into the future.

Modern methods of land drainage and irrigation can be applied to bring presently uncultivated lands into crop and livestock production. Such horizontal extensions of arable lands will, however, require considerable capital inputs, from $100 - $500/acre (it costs $800/acre to wrest Dutch polders from the North Sea). Such an investment might well be more useful if applied to vertical increases of production on lands already under cultivation.

By year 2000 it can be reasonably assumed that some 500 million to 1 billion acres of new arable lands will be added to the present 3.3 billion acres now under cultivation.

Water management is now recognized as important as soil management in the maintenance of crop production. It is estimated that more yields are lost due to the vagaries of water supply than the total ravage of all the pests combined. Therefore, new developments in soil - water conservation including subsoil waterproofing and microclimate control through mist irrigation to reduce transpiration by crop plants on highlight growing days, and to prevent soil surface evaporation can provide substantial relief from the fortuity of rainfall, and smooth the curve of water supply to a level value.

Agricultural Engineering and Mechanical Equipment

Engineering has contributed immeasurably to food and fiber production in America, in their field preparation, sowing, cultivating, irrigating, spraying, harvesting, packing and processing and finally in distribution. It has, in short, provided power to produce, so that now one man can do what it took formerly as many as 100 men at hardhand labor to accomplish.

Today, many foodstuffs are planted, cultivated, harvested, processed, packaged, transported, stored, distributed and ultimately consumed, without the hand of man touching the product. Such automation will undoubtedly be extended to all major food production areas of the world, releasing large numbers of field farm laborers for productive and advanced industrial labor in urban communities.

For the immediate present, however, it will be more propitious to provide farmers in developing countries simple farm equipment which their limited mechanical ability and inadequate literacy will allow them to employ without danger to themselves or the inefficient operation of complex machinery.

Simple metal plows, harrows, fertilizer distributors, planters, sprayers or dusters, mowers and harvesters that are horse-, mule- or oxen-drawn would be needed at first, to be later succeeded by simple small tractor-drawn equipment as the farmers became more sophisticated.

The largest engineering investment required in these developing countries is for irrigation canals, roads, railroads and rural electrification. Such programs must obviously be carried by governments rather than by industry or private capital. They do comprise, however, an area of rural and agricultural development essential to the successful production of food and fiber beyond that of a mere localized subsistence level.

Agricultural Chemicals Essential

The role of agricultural chemicals in this task will be paramount. Fertilizers, pesticides and feed additives are essential factors in the advance of food production in emerging countries. At first it will be necessary for the western nations, through FAO, AID, the various foundations, etc., to provide these materials on a gratis or long-term, low-interest loan basis. However, the returns will rapidly increase to the point where developing nations will be able to purchase their own supplies and ultimately to repay their debts.

In any event, providing fertilizer and insecticides will prove to be much less costly than giving them food or fighting them into prostration and will, at the same time, help them to become self-sufficient.

Yields of rice in Japan and Korea and of wheat in Mexico have been tripled in a decade as a result of a combination of improved plant stocks and application of fertilizers and soil amendments. The same can be done in India and in Africa and is, in fact, being done now in a few isolated places.

One ton of nitrogen fertilizer is equivalent to 14 acres of new land in returns of grain. In many of these countries there is no new land and horizontal expansion is virtually impossible, at least not without major capital inputs. Vertical expansion is the only approach to increased yields, and the opportunity for it is vast. As little as $10 of a 5-10-5 fertilizer per acre would, in most areas, more than double yields in India and could overcome their food deficiency rapidly.

Fertilizer alone, however, will merely aggravate rather than resolve the problem, for weeds, insects and disease will promptly absorb the added fertility and destroy the increased growth. It is therefore essential to provide controls for predators and pests to protect the returns from the fertilizer invested.

The pest problems in the tropics, where no winter wastage or reduction occurs, are not only quite different in terms of species and quantity but are largely unstudied and unknown to agricultural technologists.

In spite of considerable effort to establish agricultural research stations among the developing nations in recent years, there still remains a serious dearth of reliable lists of tropical plant and animal pests, their etiology, their distribution, their economic importance and their control. This is not, of course, an insuperable matter but is certainly one which must be resolved before effective crop and livestock production can be reached and sustained.

In the early stages relatively simple plant nutrition and pest control programs should be instituted. Fertilizers will have to be broadcast by hand or spread with hand-drawn or beast-drawn distributors; pesticides will have to be sprayed with hand-pack sprayers, for these people cannot afford heavy machinery, neither would they know how to use or tend it and, furthermore, in most cases their small holdings would make even small tractors uneconomic.

Because of the illiteracy prevalent in these lands, only those pesticides of wide safety margin for man, pyrethrins, rotenone, DDT, lindane, methoxychlor, Malathion and Sevin, for example, among the insecticides should be used; and obviously those compounds of broadest spectrum would be the most practical. A single insecticide, a single fungicide, a herbicide to control grasses and another for broadleaves would be about all these people could handle effectively. These would, however, do immeasurable good by increasing the yields and quality of their food.

One major and immediate use for pesticides is to preserve harvested foods in storage. Dr. Subramanyan of the Mysore Institute for Food Technology in India estimates that over 40% of the foods produced from pitifully low field harvests in that country never reach the consumer's mouth, due to the postharvest ravage of insects, decay and vermin. Here is a gap which could be rapidly filled with our modern arsenal of pesticides and the effective food supply virtually doubled in India and other hard-pressed countries. As Borgstrom points out, a simple, effective and cheap method for preserving foods between the reaper and the eater could practically double the food supply in backward countries within five years.

Another area for pesticides among the developing nations is in broad regional programs of suppression of insect vectors of human disease. The WHO of the United Nations has been carrying forward a significantly successful antimalarial program in some sixty countries, through eradication of the vector, the anopheline mosquito. This has already been accomplished in some eighteen countries, including the United States, and is well on the way to success in some thirty more countries. Its success, incidently, has been largely due to the much-maligned DDT, a chemical which has undoubtedly saved more human lives than all the wonder drugs combined.

In India alone the program has reduced the incidence of malaria from 80 million cases a year to less than 3, and associated deaths from over 5 million a year to below 100,000, with the consequent increase in the lifespan of the average Indian from 32 to 47, an increase of over 15 years longevity in less than two decades. This is perhaps the most phenomenal accomplishment in public health medicine on record.

Of course, some argue what is the use of prolonging the Indian's life if it merely gives him more years in which to starve to death.

This specious argument ignores the fact that the antimalarial program in India opened up wide areas of arable lands in Uttar Pradesh and other regions hitherto denied to man by the presence of the ubiquitous anopheline mosquito and that these same useful chemical tools can materially aid to increase the supply of foods.

There are many other pest-vectored diseases of man and his livestock which local governments, aided by the United Nations, AID and similar authorities, can suppress with available pesticides. Such pest-vectored diseases as yellow fever, bubonic plague, cholera, onchocerciasis, encephalitis, dysentery, yaws, filariasis, leishmaniasis, typhus, trypanosomiasis, schistosomiasis and a variety of virulent virus diseases not only cause incalculable losses in human health and productive vigor but in addition render vast potential agricultural lands unproductive and the peoples prostrate.

Today the tsetse fly, carrier of the dread sleeping sickness (Trypanosom gambiensis) in man and nagana in animals, virtually precludes cultivation and livestock ranging of some 4 million square miles of fertile soil in central Africa. This immense territory, larger than the continental United States, could actually produce sufficient additional plant and animal protein to banish Kwashiorkor and the swollen bellies of children that it produces from the earth. A world attack on the tsetse fly through the United Nations, using the integrated control approach advocated by Knipling, Smith, Reynolds and others, could do more for the future of mankind than a thousand trips to the moon.

Following Knipling's approach, the total population of tsetse flies could be substantially reduced by chemical spraying over the known haunts of the pest; this would then be followed with a vast seeding with male sterile flies and the strategic location of baited radioactive or chemical sterilant feeding stations. Clearly, a careful etiological and geographic study would first be necessary, followed by intensive laboratory investigation to establish the most effective pesticide, dosage method and time of application, as well as breeding studies to ascertain the precise breeding characteristics and to develop methods for raising flies for the male sterile phase of the program. All of this would, admittedly, cost money, possibly a billion dollars or more; but the return would more than repay the cost.

Eventually, the sheer presence of numbers of mankind will force us to open these lands now denied to us; then why not do it now and stave off the agony of millions of humans and the chaos it promotes?

Thus it can be concluded that the rapid integration of education and extension, animal and plant breeding, soil and water management, agricultural engineering, and chemistry and economics and marketing can indeed meet the food requirements of 7 billion humans through conventional agriculture through the year 2000.

PROSPECTS OF UNCONVENTIONAL FOOD PRODUCTION

There have long been discussions relative to the prospects of man abandoning "agri cultura" (agriculture), the cultivation of fields which like the name descends from antiquity, as the major source of his food supply and turning his modern sophistication and technology to other allegedly more efficient methods of food and fiber production. Although most of us in technical agriculture tend to scoff at these suggestions as being illusory or at best far off in the future, we should recall there are several substantial examples where synthetic and fermentation chemistry has already achieved significant competition for farm products, two such being the manufacture of fibers and rubber from fossil fuels.

As a result of the increasing pressures for living space, roads, airports, industrial sites and recreation areas arising from the rapidly encroaching population, in a number of countries (e.g., United States) more arable soil is removed from food production each year than is returned by land clearance and development. The contest between human need for food and demands for land use other than agriculture, will reach a crucial strain within the next twenty years, particularly in the United States and western Europe. It is not unreasonable to conclude that conventional agriculture will not invariably win such a contest. The most probable compromise will be to reduce the arable lands now employed to produce livestock feeds and particularly the ranging areas. Hopefully the reserved cultivated soils will be employed primarily to provide cereals, legumes, fruits, nuts and vegetables for man by conventional methods, while the proteins, carbohydrates and fats produced by unconventional processes will be assigned to feed livestock. Certainly we must face the fact that valuable productive soils cannot much longer be employed to produce rich food sources of proteins, carbohydrates and oils to feed livestock at 7:1 loss in conversion, while hundreds of millions of humans are faced with continuous starvation. If western man wants to continue his luxury diet, and concomitantly prevent social anarchy he must find sources of protein and energy for his livestock that are non-competitive with man. This can be accomplished by turning our modern technology to unconventional sources of foods.

There are four general approaches to non-agricultural food production:

1. Aquaculture - water plants
2. Pisciculture - fish culture, both fresh water and marine
3. Fermentations of by-product and waste sources of energy
4. Direct chemical synthesis

There is also, however, the possibility of domesticating additional or substitute species of livestock, such as the eland, an African antelope capable of grazing effectively on submarginal soils generally unsuitable for intensive cultivation; the capybara, a dog-sized rodent indigenous to South America that feeds on aquatic weeds generally regarded by wildlife experts as nuisance growth; the manatee, a large seal-like, water-dwelling mammal whose habitat is both fresh and brackish water where it feeds on aquatic weeds, particularly narcissus; finally, both the musk-ox and the buffalo or bison are being restored into the family of man's livestock in the western world after near extinction. The musk-ox in northern Maine and Canada, where its extraordinary capacity to withstand cold and to feed on virtually useless roughage, provides an effective means to convert and store animal protein, and the American bison, which is an excellent meat animal that was the protein mainstay of the American Indian for perhaps 10,000 years. As none of these useful livestock species constitute competition for protein and energy sources consumable by man, but on the contrary convert unusable feeds into high-quality food for man, they represent important solutions to the animal protein deficiency in the human dietary.

1. Aquaculture - plants

The cultivation of hydrophilic and aquatic plant life, both fresh water and marine species, for a food source has been practiced to a limited degree in a few land-hungry countries, notably Japan, for centuries. It has received some scientific consideration in recent years, again chiefly in Japan, but it certainly has not been given the research and technical investigation it merits. As the coming struggle for food mounts aquaculture of suitable plant species offers the most promising potential source of protein and energy for livestock feed to replace that which now competes directly with man.

A number of broadleaved plants generally considered pests in inland waterways and lakes could readily be deliberately cultivated, harvested, processed into silage or dried as forage and fed to livestock. This would release both arable soils and foodstuffs and continue to produce rich animal protein for humans.

The most promising aquatic plants, however, are to be found among the green algae. These unicellular green plants are exceedingly efficient in converting solar energy into carbonaceous tissue, and can outyield most cultivated terrestial green plants by a factor of twenty- to thirty fold.

There are four distinct materially important objectives that research into the systematic cultivation of green algae could fulfill.

First, they can aid substantially in resolving the present and growing problem of water pollution, particularly that of sewage effluents. Research already carried out by the University of California at their Richmond algae farm by Oswald and associates has shown beyond dispute that 1 million gallons of raw sewage can be restored to virtually potable condition while producing 1 ton of dried algae. On this basis, urban effluents in the United States alone could produce from 50 -75 million metric tons of a 45% protein animal feed per year.

Second, such green algae, suitably selected for species and strain and genetically bred for animal nutrition, can provide a substantial component of feedstuffs and replace soybeans, corn, wheat and fish meal now competitive with man.

Third, use of high-cellulose, long-celled species and strains could provide a cheap source of paper for newsprint and relieve the strain on our forests.

Fourth, research into the myriad species, varieties and strains of algae, many of which can be readily mutated, will yield new sources of biochemicals, such as pharmaceuticals, pesticides, additives, etc.

Within the next 20 to 30 years it seems certain the algae, green, red, brown and blue, will be increasingly researched for these purposes, and may well develop as a major source of protein for man and animals and coincidently a means to reduce pollution in our water supply.

2. Pisciculture

Although fishing is an age-old source of protein and still today constitutes a major source of food in many countries, particularly coastal nations, the methods employed are still basically a hunting operation, with little or no regard to replenishment for future needs. Modern technology has, of course, materially improved the efficiency of commercial fishing. Such equipment as canning and freezing mother ships, sonar finders, bubble and electrostatic curtains have increased both the size and frequency of catches and enhanced their economy. Employing such methods both the U.S.S.R. and Japan have obtained undisputed leadership in the annual world fish haul.

Without internationally organized and administered fishery control to allow for replacement, however, it does not seem likely that the present world annual fish haul can be increased economically and consistently by more than twofold, or from the present approximately 45 million metric tons to 90 million tons. In terms of pure protein this constitutes an increase from the present 8 million metric tons to perhaps 16 million metric tons, or about 10% of the estimated minimum world need for protein in 2000. This is an important contribution but not a particularly promising continuing one, at least by present methods.

Fish farming, however, indicates a considerably greater potential. As it would, obviously, involve control of the site, of the species selection, of the nutrition and of pest and predators, the recovery on invested time, effort, facilities and capital would be much better assured. Both brackish coastal waters as well as inland fresh water lakes could be cultivated. In addition pisciculture could be tied in with algae culture in many areas, particularly of urban populations where sewage disposal and resultant water pollution are also major problems.

The harvested fish could be crudely processed into animal feeds or with greater refinement into fish protein concentrate (FPC) for supplementing human diets.

In Europe, southeastern Asia and Japan where pond culture of fish has been practiced for centuries, yields have already reached 1 ton/acre and marine biologists estimate that by seeding optimum species, and scientific control of nutrition, diseases, predators and water management, yields up to 100 tons/acre/yr. with certain species can be anticipated. At such yields 1.5 million acres of cultivated waters could produce all the animal protein required by humans in the year 2000. One major factor in such a program is that there would be no international contest as to whom the fish belonged.

3. Fermentations of waste organic by-products

In recent years considerable interest and emphasis has been directed at the production of protein from waste organic by-products by controlled fermentation with bacteria, fungi and yeasts. All such are basically conversion processes, completely dependent upon some external source of energy. They are useful, therefore, only when such conversions are from a low-grade virtually useless source of energy to a high-grade useful product. This is readily achieved in the fermentation production of low-volume, high-priced antibiotics, vitamins and steroids. These high-priced products can effectively support high-cost, sophisticated equipment and personnel. For high-volume, relatively low-priced foodstuffs such as proteins, fats and carbohydrates, however, the economics become crucial, and production must be achieved with a relatively low-cost overhead from a raw material in abundant, continuing supply at virtually zero cost. The classic case of this type of operation is the torula yeast fermentation of waste sulfite liquors in the wood pulp and paper industry. Even this product exceeds comparable conventional sources of protein by a 2:1 cost, and without the depollution credit for removing a serious contaminant from the effluent could probably not sustain itself.

Upgrading the digestible nutrients by semi-solid silage fermentation of such waste by-products as bagasse, corncobs, oat bulbs, fruit pomace, beet and citrus pulp, feathers, hair, packinghouse and fishery offals and certain manures as silages in temperature-, gaseous- and moisture-controlled silos (Harvestores) conveniently located close to the by-product source show promise as feed supplements for finishing ruminants. They may ultimately be developed sufficiently to be fed to monogastric livestock, such as hogs or poultry.

The differential fermentation of the aliphatic (paraffin) fragments of crude petroleum oils from the aromatic (naphtha) moiety by means of yeasts and bacteria that employ hydrocarbon sources of energy has received extensive research in recent years, particularly by industrial oil and chemical research labs.

Champagnat has developed a large pilot plant operation at Lavera in southern France, supported by British Petroleum, and indications are they will be in substantial production of yeast (Candida) protein for animal feed supplements in the early 1970's and for human food supplementation a few years later. Champagnat estimates that two tons of crude oil will produce one ton of pure protein, and that the required 160 million metric tons of protein required to feed the world population at subsistence level in 2000 could be produced from 320 million metric tons of crude oil or approximately 1/4 of the world crude oil production (1.25 billion tons) for 1962. Again, however exceedingly sophisticated equipment and operational overhead are essential; there is the omnipresent hazard of contamination of the culture by a wild yeast strain, bacteria or a phage which could radically alter the quality of the protein produced, possibly rendering it toxic; and the best estimated cost (unofficial) of the product is from two- to threefold that of comparable grades of oilseed proteins (soys and peanut), which are more likely to be acceptable for human consumption.

Nevertheless petro-protein must not be discounted as it may make a substantial contribution to the resolution of world protein hunger within twenty years. It may well find significant use in the Near East where petroleum wastes are abundant, protein foods are seriously deficient and arable lands are limited. There are a number of other oil and chemical companies working vigorously in this field including Jersey Standard, Shell, Sun and I.C.I. Shell and I.C.I. are researching the use of natural gas as a carbon source for fermentation production of proteins.

Dr. Humphrey (University of Pennsylvania Engineering College) contends production of single-cell protein (SCP) including yeasts, bacteria and algae will, by 1980, so supplement conventional agriculture, fish culture etc., as to prevent mass starvation of the human population.

4. Direct chemical synthesis of foods

The chemical synthesis of foods, particularly of protein, has been vigorously promoted by Dr. A. McPherson, formerly prominent chemical engineer with the National Bureau of Standards. He played a leading role during World War II in the supplanting of natural rubber with synthetic butyl rubber, which kept the United States Army and the country rolling. Now McPherson contends no realistic expansion of conventional agriculture can possibly meet the needs of the burgeoning population in time to prevent wholesale death from hunger.

There are, of course, some ten major essential food components that are synthesized now by the chemical industry for supplementing both human and animal diets. These include 11 vitamins (A.C.E and K, choline, niacin, pantothenate, thiamin, folacin, pyridoxine, biotin), and at least two amino acids, lysine and methionine (or its analogue). Again, however, these are low-volume, high-unit price components, while proteins would have to be high-volume, low-unit price products to compete against conventional agriculture and the other biological production methods discussed.

Finally, although the total synthesis of foods, from fossil fuel primaries or from atmospheric nitrogen, carbon dioxide and oxygen, cannot be ruled out as impossible, it is clear a vast amount of research and development must precede any reasonable productivity which in effect renders the proposal quite unrealistic for the foreseeable future, i.e., to year 2000.

CONCLUSION

Despite predictions to the contrary from some, obviously uninformed quarters two-thirds of the humans on earth are presently in a state of chronic hunger; despite the increasing efforts of social scientists, health officers and religious leaders combined to curb the burgeoning population by reducing birth rates, demographers confidently predict the number of people on this planet will exceed six billion by year 2000. Therefore, the current desperate food gap existing today will inexorably increase to virtually catastrophic proportions within the next decade and will advance into complete socio-political chaos that will envelop the entire world before the end of this century, unless agricultural science can stem human hunger sufficiently and long enough to allow the much slower-acting pressures on population restriction, the "people-stat," to take significant effect.

It can be unequivocally stated on the basis of evidence, facilities, capital inputs, and technical know-how, available today, that conventional scientific agriculture has the capacity to meet the entire food needs of mankind through year 2000 up to a population of from 7 to 10 billion humans. Beyond that number non-conventional methods of food production can supplement human and animal diets up to a population of 15 billion, and perhaps beyond.

Conventional agricultural methods would include extending to needy nations improved crop plant stocks of cereals, corn, legumes, roots, tubers and forage grasses, and improved and adapted stocks of ruminants, swine and poultry where acceptable; providing at minimal cost, and even free where necessary, complete fertilizers (N.P.K.) to provide 20 lbs. of N, 40 lbs. P_2O_5 and 20 lbs. K_2O per acre plus lime where required, to those farms which have been assessed as capable of using such soil nutrients effectively on their crops; to provide modest levels of pesticides, particularly insecticides, fungicides and herbicides, to meet crucial pest problems; to develop improved storage and preservation facilities for harvested crops; to supply simple mechanical equipment and tools to husband crops and animals more efficiently; to improve transportation from farm to urban areas; finally to establish sound and reliable fiscal policies so that external capital can flow in with confidence and without fear of overburdening taxes and licenses, overriding political management or outright expropriation.

Initially such a program would show no financial profit to the investor, although it would produce substantial returns in humanity. After a few years when the developing nation approached the "take off" stage the "payback" would be both rapid and complete. Those companies which take the plunge and invest in these developing countries while they are still in the primary emerging stage have the best chance of remaining there and flourishing.

For the long-term view, beyond year 2000, research must be accelerated now to meet the food demands of at least 10 billion humans. Hopefully the "people-stat" will kick on in time to prevent the population exceeding 10 billion.

It is imperative research and development into conventional agriculture including plant and animal breeding, engineering, and chemistry--particularly biochemistry--be carried forward undiminished. Soil and water management research are of top priority in this program. Food preservation and processing together with distribution, transport and marketing also constitute essential areas for further research and development.

It is in the areas of non-conventional agriculture where research may yield sufficient additional foodstuffs to supplement the products of conventional agriculture to the level where no human on earth will have to accept a dietary below 2200 calories and 60 grams of protein per day.

The most promising areas for non-conventional food production are aquaculture of plants, pisciculture, biological fermentations, particularly silage digestion of organic wastes and yeast fermentation of aliphatic petroleum residues, and by total synthesis from atmospheric, marine and fossil primaries.

Perhaps in conclusion it would be well to recall once again the writings of Thomas Malthus who for so long was forgotten or derided and who was for over two centuries the one truly accurate prophet of society since biblical times.

> "But at Nature's mighty feast, none are bishops,
> but all are men; there is no distinction; all
> that are invited are at liberty to partake, and the
> life of a guest is sacred; to be invited to the same
> table implies equality, and to possess life is to possess

the invitation. The table is not spread by any set of men, they only pluck the fruit; the Master himself presides, and all he invites are equally welcome. Nor is it the prerogative of one guest to dismiss another from the hall; the Master calls on whom he will to vacate a seat, and his voice is irresistibly heard by all."

"Has then all the fruit been gathered? When it has, then, perhaps, will be the time to charge our Maker with folly. Until the uncultivated land has been brought under the plough, and the exigencies of Nature taxed to extreme, it is improper to say the bounty of Providence is not equal to the wants of man."

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INTO THE FUTURE WITH AGRICULTURAL CHEMICALS

by

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Food and fiber production is America's greatest asset; it is the basis of our standard of living and our national prosperity. The efficiency of our farms is such that our burgeoning population is more than adequately nourished by the work of less than 5% of our people, releasing 95% to advance our industry, our public works, our education, our research and to enrich our culture and to maintain our defense. For the first time in man's long struggle against want, America has, in this century, accomplished the means to banish hunger and exposure from the earth.

This achievement has been the work of many people in all the walks of science and farming. Among these, chemistry has contributed substantially to the many advances in soil fertility, plant and animal nutrition, pest control and food processing, preservation and distribution. These contributions are abundantly reflected in the vast array of wholesome, nutritious and high quality foodstuffs available, virtually at all seasons, to the consumer, at an average cost of less than 20% of the take-home dollar. This is the lowest cost for the highest nutritional level of any country in history. Agricultural chemicals, including pesticides, are essential factors in the efficient production of our foodstuffs and, in addition, these chemicals are primarily responsible for the reduction and control of many major insect vectored diseases, thereby contributing to the health and longevity of our people, and to those of many other countries around the world where such scourges have caused the early death of countless millions of mankind.

The recent clamor directed against agricultural chemicals is generally gross distortion of the actual facts, completely unsupported by either scientific experimental evidence or practical experience in the field. The assertion that pesticides are the sinister companions of radioactive nuclear fall-out is simply ridiculous. The contention that our lands and the waters beneath have been universally and irrevocably contaminated by an indiscriminate rain of pesticides is firmly contradicted by documented federal and state surveys and records which show less than 5% of the land area actually exposed to such chemicals in an average year. The suggestion that insecticides, fungicides, herbicides and nematocides are in fact "biocides," destroying *all* life, is obviously absurd in the light of the fact that without selective biological activity these compounds would be completely useless. The claim that resistance to an insecticide among a particular species of insect necessarily invokes biological superiority is confronted with the experimental evidence that insecticide resistant strains are found to be biologically inferior.

The asserted damage to wildlife by pesticides has been crassly exaggerated. At worst it can only be considered a minute fraction of that caused by natural causes such as frost wastage, flood, drought and epizootic diseases and predation. At best pesticides have contributed substantially to wildlife welfare by protecting forest canopy and grazing verdure through control of insect ravage and disease.

There are many other areas of man's activity that press upon wildlife which are considerably more harmful than the worst of agricultural chemical practice, notably highways, airports, cities, factories, mines, power lines, TV towers and, especially, the overwhelming encroachment of billions of humans upon the haunts and feeding grounds of wild creatures.

The real danger to man's survival lies not in the controlled use of chemicals but in the hoards of insects and miasma of disease which would sweep over our crops and animals, denude our forests and leave hunger and destitution and want in their wake.

If many of the proposals recently directed against the use of chemicals in agriculture were to be actually carried out, life in America and all over the world would return to the Dark Ages, and insects, disease and vermin would once again inherit the earth.

The use of chemicals has become an integral part of agricultural practice, and to the modern farmer the production of crops and livestock without fertilizers, pesticides, medicaments and feed supplements is simply impossible. For the grower fully realizes that he must bring his fruit and vegetables, his meat, milk and eggs to market unblemished and unbesmirched by insect or disease and uncontaminated by pesticides beyond minute and exceedingly limited legal tolerances, or he cannot sell his produce within the strict standards laid down by Federal and State regulations for prices at once acceptable to the public and profitable to him. It is to help the farmer meet his goal amid these encircling pressures that the land grant colleges, and the experiment station system, the U.S.D.A. and the industry work together to provide the tools, the chemical products and the requisite technical knowhow. This collaboration has been manifestly successful over the past century and there is every reason to believe it will have to be even more efficient in the future, when the demands for a rising food and fiber supply from a declining land area will provoke immense logistical problems of production. The sacrifices in yields and quality and time to market made to pests will shortly be no longer tolerable, for even with the wide use of pesticides our losses in crops and livestock exceed $20 billion annually; this aggregates over 25¢ of every commodity dollar at farm level prices.

Food production can therefore be rapidly increased at least 10 to 20% in quantity and even more in quality by merely suppressing pest predation further than we now do here in the U. S. Around the world application of current U. S. methods of pest control could easily double the food supply within five years and banish hunger from the earth.

The future trends in pest control will continue to rely upon chemicals, but other tools both physical and biological will also play increasing roles. Thus new chemical pesticides will be designed to combine wider margins of activity between invertebrates and vertebrates, with high target specificity, short residual activity and ready biodegradability. In addition, novel and discriminating methods of use and application will be devised to concentrate the pesticide to the intended host crop or livestock with a minimal incidental contact among nearby plants or animals.

To achieve these objectives research will move increasingly towards metabolism, mode of action and fate of pesticidal compounds, seeking to find specific physiological and biochemical pathways unique to pest species which would be susceptible to particular attack.

Thus the fact that many pest insects use trehalose, a particular 12 carbon sugar not found in vertebrates, as a means of energy transfer, suggests that a chemical which would interfere with the effective use of trehalose by the insect would be a powerful insecticide and one to which the insect is unlikely to develop resistance.

Many insect pests of the beetle and grasshopper families are covered with a hard shell (or exoskeleton) of chitin which, if dissolved or hydrolyzed by a chitinase type chemical, would destroy the structural integrity of the insect.

Already major advances have been achieved against several members of the moth or butterfly family (Lepidoptera), the fly family (Diptera), and the cockroach family (Orthoptera) by the isolation and identification of some nine different sex scents, homologues of two of which have been synthesized. These incredibly potent compounds--(which in some cases are calculated to be effective down to a few hundred molecules)--are absolutely specific for they only attract the males of a single species. These misled fellows can then be either fed a sex sterilant or exposed to a sterilizing dose of gamma radiation and released to mate futiley with expectant females who being chased remain chaste and lay only sterile eggs. This practice rapidly reduces the species population at an accelerating rate.

The astounding success in the eradication of the screw worm fly in the Southeastern states following the repeated release of irradiation sterilized males attests to the indisputable efficacy of this technique. Interestingly, one can show mathematically that direct chemical control is most effective when the pest population is high and becomes increasingly less effective as it declines; whereas the male sterile technique is least effective when the pest population is high but becomes increasingly effective as it declines. Clearly an integrated program which begins with a chemical and terminates

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with the sterilized male approach should prove an immensely powerful tool in future insect control. It would be a particularly potent program against massive epizootics of forest insects such as the gypsy moth, the spruce bud worm and the pine needle miner, and could be employed effectively in large orchard areas where build-up of specific orchard pests can attain disastrous proportions.

Furthermore, such an integrated program will substantially reduce the probability of insecticide resistance developing, for after the chemical has removed all the susceptible insects, the resistant ones are then removed by the sterile technique and carry their insecticide resistant genes into oblivion.

Recent research into the biochemistry of metamorphosis among insects has led to the isolation of certain growth hormones which when applied at the incorrect stage of growth cause a reversal in development and eventual death. These again are quite specific and totally safe to vertebrate creatures, or so we presently believe. At the moment they are quite impracticable, being too costly; but when they are chemically identified and perhaps synthesized then they may prove to be exceedingly powerful and useful insecticides.

Biochemical research has now turned to a new array of so-called off-eating compounds, one of which (4'-dimethyltriazene acetenilide) Wright found to cause off-eating in the Southern army worm, the Mexican bean beetle, the Jap beetle, the asparagus beetle and the cabbage worm. It was generally active against chewing insects, who presumably picked up a mouthful when they took a bite or two, while against sucking insects such as mites, aphids, leafhoppers or squash bugs that pierce the leaf surface to feed on the juices within, it did not appear to be effective. Its mode of action is not as yet determined, but the frustrated pest takes a bite or two and then just sits there and starves to death. Tests to date indicate these substances would be completely safe to preferred wildlife (i.e. birds, mammals, fish, etc.).

Perhaps the greatest advance achieved in pest control chemistry within the past decade, has been the discovery of systematism among certain of the organophosphate pesticides, such as phorate, demeton, dimethoate, disulfoton , and TEMIK among the plant protectants. Here control can be absolute against target insects and harmless and beneficial predators remain unaffected. The treatment is essentially prophylactic in effect as it precludes attack, rather than turning back an accomplished infestation. The treatment is simple, practicable and of prolonged effect. Some compounds like phorate and disulfoton can be applied as granules to the host plant roots at planting or in early spring in the case of tree and bush plants. The active principle is absorbed and translocates up the plant and out into the foliage where it remains while it becomes slowly metabolized. Others such as dimethoate when sprayed topically on the foliage penetrate and migrate through the plant even into the roots, where nematodes and soil insects are controlled. The only problem still remaining with these compounds is their mammalian (and human) toxicity in the early stages following application. However, strict adherence to the recommended label instructions will avoid any difficulty.

Interest in biological control of insects through release of predatory insects, pathogenic fungi, bacteria and viruses will continue to receive the attention of many entomologists, primarily because it appears to be so safe to humans and wildlife. However, for the practical grower, the available methods, which are only a handful against thousands of pests, are too specific, too late, too ephemeral, too unreliable, too complicated, too impracticable and too costly to rely upon to produce crops with the necessary economic efficiency. There is not one commercial crop or livestock animal which can be economically produced to meet current Federal and State standards of quality and be completely protected by biological methods of pest control. If the grower must invest in chemicals and equipment to protect his crops against 14 of 15 pests, he might as well catch the 15th en route -- he would anyway.

Fungicides will continue to trend away from the heavy metal compounds and towards the organic compounds which have broad spectrum and high biodegradability.

The next major breakthrough in agricultural chemistry may well be a broad spectrum systemic fungicide which when applied to foliage will translocate down stems into roots and control vascular disease such as the wilts. The recent discovery that thiabendazol has systemic fungicidal activity in plants is a most promising development.

It will be in the field of herbicides where the most rapid and vast developments will occur in agriculture. The future goal will be in creating the weed-free environment particularly among those crops which cannot be weeded by mechanical methods, such as cereals, hays and pastures. Differential chemical herbicides are the only effective approach to weed control among these crops.

For orchard crops, herbicides can be most effectively employed at sublethal doses to reduce orchard cover growth without losing the soil to wind and water erosion.

These then are the goals of modern agricultural chemistry; and as we move into the future the uses of the past instruct us to take our agricultural science, including our agricultural chemicals, with us or we shall surely fail to win the battle for food, fiber and health.

We shall do this with widening understanding of both the benefits and hazards involved and an increasing appreciation for our own safety and that of the wild creatures who dwell upon this planet with us.

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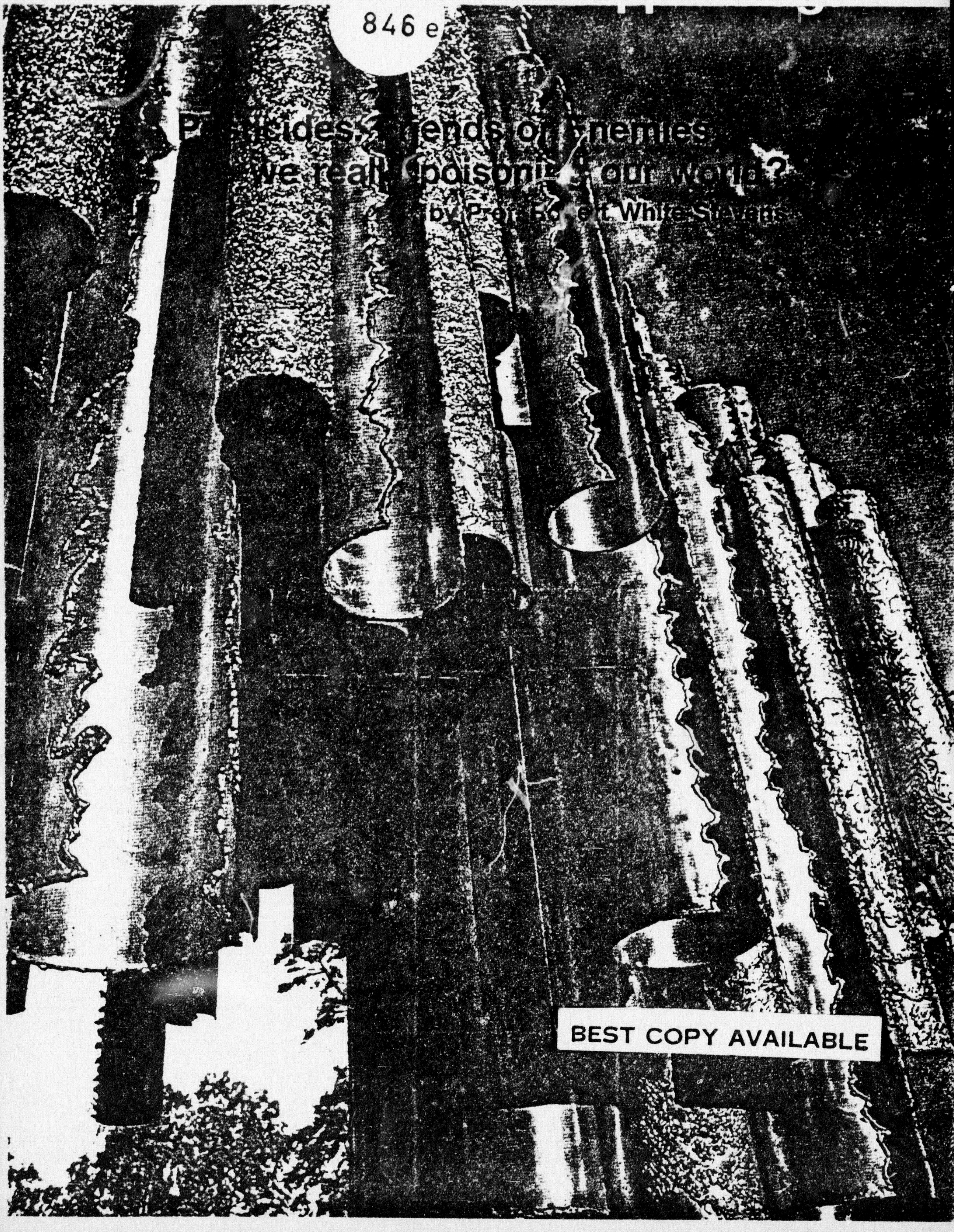
Pesticides: friends or enemies?
we really poisoning our world?

by Prof. Robert White-Stevens



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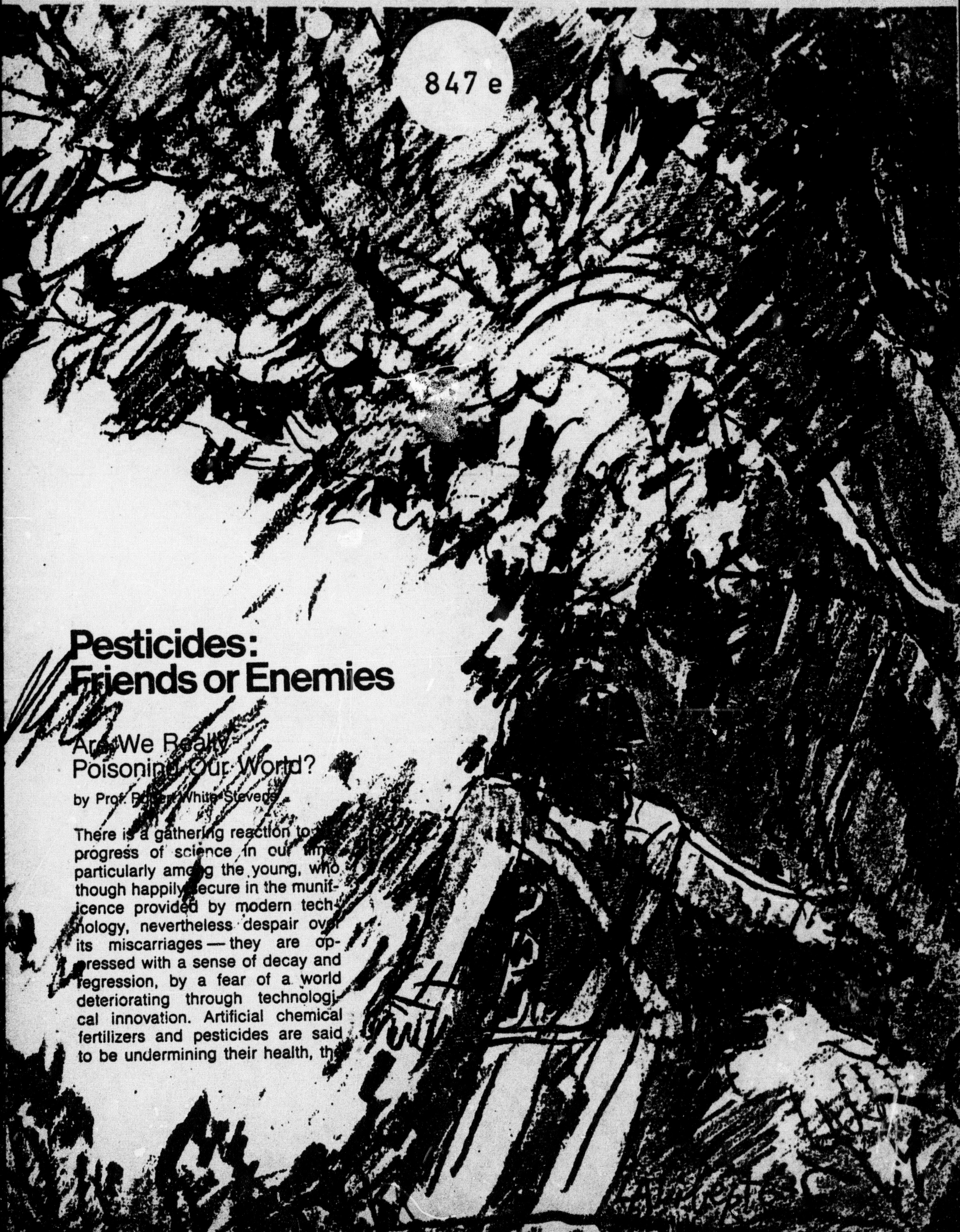

Pesticides: Friends or Enemies

Are We Really Poisoning Our World?

by Prof. Robert White-Stevens

There is a gathering reaction to progress of science in our time, particularly among the young, who though happily secure in the munificence provided by modern technology, nevertheless despair over its miscarriages — they are oppressed with a sense of decay and regression, by a fear of a world deteriorating through technological innovation. Artificial chemical fertilizers and pesticides are said to be undermining their health, th

soil and the sea are being poisoned by chemicals and radioactive wastes, drugs merely substitute one form of disease for another, and modern man oscillates continually under the influence of stimulants and sedatives.

This feeling of despondency seems to prevail everywhere. Even knowledgeable, intelligent people are seeking refuge in an elevated form of mystical nuttiness.

Thus we condemn the antibiotics because they elicit allergic reaction among a few, while they restore the health of many; we decry the use of medicaments in livestock feeds because minuscule and innocuous residues may occur in our food supply, the quality and quantity of which is vastly enhanced by their use; we accept as our rightful heritage the total elimination of vast areas of hunger and disease, yet we clamor furiously over the exaggerated and imagined dangers of pesticides.

There is a tendency, even a perverse willingness to suppose that the despoliation sometimes produced by technology is inevitable and irremediable, a trampling down of nature by some huge inexorable machine. Actually, of course, whatever environmental deterioration is induced by technology is a problem for which science has either found or will shortly find a solution.

Complaining about the rape of our environment by technology when the need is to seek and apply adequate regulation of unwanted side effects is futile. Panning scientifically established uses of certain pesticides when the overwhelming facts dictate that our food supply, our health and the entire measure of our living standards would clearly be threatened and ultimately impaired by such rash and ill-considered legislation is ridiculous.

Billions of babies

The major environmental insult in the world today is the accelerating increase in the human population. Even conservative estimates now concede the world level will exceed six billion by the year 2000, and a more realistic figure is seven billion. The major thrust of this fantastic increase continues to be in Asia, which may well support a population almost equivalent to the rest of the world combined by 2000. However, both South America and Africa are increasing as rapidly as Asia today. Although western Europe has virtually reached a plateau, eastern Europe continues to increase. Even North America may well exceed 400 million people by the turn of the century. In a recent Census Bureau projection the U.S. population alone is expected to reach nearly 322 million. Either man will find an effective solution to curbing his numbers or nature will do it for him.

In the meanwhile, scientific agriculture can hold "a finger in the dike" certainly through year 2000 and perhaps beyond to provide food for up to 10 to 12 billion humans, through the worldwide application of food production technology now on the books, together with new developments achieved over the next 30 years.

This, however, can only be done if the work is allowed to continue and expand without hampering legislation and regulations promoted by an irresponsible and uninformed minority.

Nonnegotiable demands

In spite of the vast advances in agricultural technology in the Western world and massive efforts to spread this technology into developing countries, the hunger gap has continued to widen between the "have" and the "have not" nations since World War II.

Food and fiber production will have to double in the Western world, increase threefold overall to maintain subsistence levels in the populous developing nations, and protein production will have to increase sixfold to meet the needs of a world population of seven billion.

It is impossible for the Western world to continue to make up the deficits in the developing countries by supplying surplus foods; these deficit nations must develop their own food production resources.

There are two approaches to meeting the stupendous demand for food over the next 30 years.

The first, horizontal expansion into new and, as yet, untapped potentially arable land, is the most obvious and perhaps the more readily achieved. However, it will constitute the more serious threat to the environment and will press wildlife into extinction more rapidly.

This would require considerable capital input, perhaps from $100 to $500 per acre or its equivalent in work energy. Large as this may appear it is not an unreasonable investment for developed countries. Tremendous opportunities for vast land development lie waiting in South America, central and South Africa, and of course, Australia. The potentials for arable land development in eastern Europe, particularly Roumania, and southern Europe and the vast reaches beyond the Urals, are only vaguely known, but will undoubtedly be considered as the hunger of man rises.

It is reasonable to anticipate that some billion acres of newly developed arable lands will be added by year 2000 to the present 3.3 billion now under cultivation. However, this will only still provide about one-half acre of cropland per person—far less than the subsistence requirement computed by the USDA (United States Department of Agriculture) back in the 50's at around 2.5 acres per person.

The second approach, that of vertical expansion, or increased productivity per acre will, therefore, become mandatory, even if the present arable area is increased by 33 percent.

The possibilities for such a vertical increase are exceedingly promising. For example, in the U.S. within the past 30 years, grain yields have more than doubled and grain production per farm worker has advanced sixfold. These advances are reflected by the lowest cost in food supply to the consumer for the most abundant and highest quality food supply at all seasons of the year that any nation has ever achieved in history. It also allows five percent of the population to provide all the food for all the people.

About the bugs

No amount of productive efficiency or reliance upon natural controls of pests can ever be expected to attain a productive margin ahead of their ravages. Their rate of reproduction is far too rapid for farmers to be able to raise food in sufficient amounts to feed both pests and humans. The pests will win it all virtually every time.

Estimated annual losses of crop plants and livestock in the U.S. currently approximate $20 billion, even with our intensive pest control measures and efficient pesticides. This is a tax of 25 cents on every dollar spent for food.

It is anyone's guess what the loss would be if we used nothing. Conservatively, yields would drop to less than 50 percent and food costs would undoubtedly increase four to five times. The quality of the produce would be totally unacceptable to the modern American housewife.

In India, for example, where chemical pest control is minimal, as much as 50 percent of the food from the very low yields harvested never reaches the consumer's mouth. Thus the application of simple protective pesticide measures could virtually double the effective food production in a land where 300 million people are continually on the verge of starvation.

There can be no point in promoting increased crop and livestock production by introducing improved plant and animal stocks, applying fertilizers or providing irrigation facilities if the increment yields are to be devoured by pests. Pesticides necessarily become an integral part of agricultural improvement programs among all developing nations.

A matter of life or death

Pesticides, particularly the persistent organo - chlorine compounds, effect their most significant impact in the field of controlling insect-borne human diseases. DDT alone has saved more human lives than all the wonder drugs combined.

Malaria, as far back as history records, has been the greatest disease killer of mankind. More human beings have perished from malaria than all other infectious diseases combined.

When DDT was first introduced into India through the UN World Health Organization program to fight malaria, there were over 75 million cases a year with upwards of five million deaths. Within 10 years intensive spraying of houses and breeding sites so reduced the vector that the total incidence per year was down to less than five million cases, with less than 100,000 deaths, probably the most fantastic achievement in the history of public health medicine.

On the island of Ceylon, where malaria had raged for millennia, the disease was virtually eradicated by 1950. Except for a few imported cases, malaria remained absent until the DDT spray was abandoned for questionable political reasons. Gradually, but with accelerating momentum, the Anophelene mosquito returned. By 1968 nearly 500,000 people came down with malaria and its incidence in 1970 exceeded one million in a population of eight million. The Singhalese Government wisely decided to return to the use of DDT.

In spite of all the furious clamor of late by a vociferous minority, no evidence of injury, cancer or death to the one billion humans who have been exposed to DDT has ever been authoritatively reported after 25 years of use. Not one invidious claim has ever been medically established. Even workers in DDT plants, heavily exposed to the technical compound daily at a level at least 200 times that of the general population for upwards of 19 years, revealed no significant clinical effects.

Perhaps the most cogent evidence that the correct use of DDT and other organo-chlorine pesticides is safe, lies in the fact that insurance companies which underwrite workers in pesticide plants or in pest control operator companies do not demand a higher risk premium for coverage. They do not do this out of any misplaced generosity, but merely because they cannot point to an actuarial risk history that would justify increased premiums.

Wrapped in DDT

Essentially, many ecologists and conservationists are concerned primarily with the persistence of pesticides in the environment to which they are applied. It has even been stated that over 95 percent of all the DDT ever applied is still present as such, or as its biologically active derivatives, and continues steadily to impregnate the entire planet, land, water and air.

This is absolutely untrue. To begin with, the older pesticides such as lead arsenate, the mercuries and coppers are indeed permanent as they never degrade. This is not true of the organic pesticides including DDT and the other organo-chlorines. Some, such as the organo-phosphates, have half lives measured in hours or days, although many of them are exceedingly toxic to wildlife for the period they are around. Others, such as DDT and the other organo-chlorines, have half lives measured in days, weeks, months and in a few instances, years. Their rate of decay is subject to many environmental factors including temperature, moisture, light and the presence of organic matter and microflora. The particular combination of these factors determines the actual half life in each case.

Organo-chlorines are, as a group, highly insoluble in water so their movement in water is both slow and minute. They do, however, have a strong affinity for fats, oils and related fatty substances and they tend to be easily absorbed by organic matter. When streams or rivers do become contaminated at measurable levels with DDT, it is usually through erosion of treated soil which carries the absorbed pesticide into the water where it remains, settling with the soil into bottom muds. There it slowly decays. This has been verified by long-term monitoring of estuarine waters and bottom deposits at the mouths of our major river systems. The Mississippi delta is particularly significant in these studies as this mighty river system drains a vast agricultural area where millions of pounds of pesticides are applied annually. If, indeed, there actually was a steady drift and accumulation of DDT and derivatives in our waterways, the mouth of this great watershed would reveal it. It does not, after nearly eight years of intensive investigation.

In sandy, dry soils in mild climates DDT and derivatives do persist, in some cases, with a half life of up to 10 years.

Toxic travelers

Even though most organo-chlorines have minuscule evaporative potential, they can co-distill with water into the atmosphere and be carried over great distances to return ultimately to earth or sea in rain or snow. However, only exceedingly minute quantities actually migrate in this fashion. Furthermore, such airborne contamination is sensitive to ultra-violet light and a substantial proportion is degraded before it returns to earth.

Pesticides in perspective

Small quantities of DDT and derivatives have been detected in remote places on the planet where, presumably, no direct application has been made. This is true of many other toxic substances, including arsenic. Many of these studies are more an accolade to the exquisite refinement of our modern analytical techniques than an ominous warning of the poisoning of the total environment.

DDT and derivatives found in Antarctic penguins is a case often singled out. Actually, the amount was so trivial, that if the entire Antarctic penguin population carried the same level (which they did not) the total amount of DDT or its equivalent would aggregate about half a pound for the entire continent. Nor was DDT detected in snow samples taken, so there is no evidence that the wildlife data indicates a universal contamination of this remote area. It seems far more probable that the observed DDT came from Antarctic explorers' wastes and rubbish. Similar sources are suspect for the occurrence of DDT and derivatives among fish caught far out to sea.

There have undoubtedly been fish kills among inland streams and waterways that are in small part, at least, attributable to pesticides which entered the water either by direct application or by erosion of

Illustrations by LaLiberté

treated nearby soils. In a few cases, irresponsible dumping of residue sprays or old containers directly into streams has killed fish.

However, the published records of unnatural fish kills in the U.S. over the past seven years reveal that only one to three percent of the total kill can actually be assessed against pesticides. Municipal and industrial wastes, on the other hand, account for over 70 percent of the kill each year.

Bird facts

Concern over the impact of pesticides upon terrestrial wildlife, particularly birds, is not entirely void of justification, but again it has been exaggerated out of all proportion to actual facts.

Consider that insects and disease destroy each year more than 30 times as much lumber and trees as all the forest fires combined, and, with that insect destruction go vast ecological areas for feeding and nesting of birds and other wildlife. Consider also that insect-borne avian diseases, a number of which are transmissible to man, destroy literally millions of desirable birds — e.g., pheasants, quails, ducks, doves, etc. It would seem a very strong case for the contributions made by man's use of pesticides to the welfare of wildlife. Certainly an unrestricted plague of grasshoppers readily destroys the wildlife along its extended paths. Last summer the gypsy moth denuded over 100,000 acres of forest in northern New Jersey: the wildlife — birds, mammals and even snakes — left the ravaged areas in droves, for they had no food, no nesting place and no shade.

Despite the emotional and sensational assertions in the American press, there is actually no valid evidence that any registered pesticide applied correctly has ever invoked massive irreversible bird kills of any species. Even where accidental spills or irresponsible exposures have on occasion occurred, the resulting kills have been insignificant compared to kills elicited by winter wastage, storms, disease and such other man-made hazards as skyscrapers, TV towers and traffic.

Contrary to the oft-quoted myth initiated in Rachel Carson's *Silent Spring*, where the main concern was over the alleged rapid decline in bird life in America, careful bird counts made over the entire country and published by the National Audubon Society reveal that many favored species of birds have actually increased in numbers in many areas of the country. Thus robins, starlings, sparrows, seagulls, ducks, wild turkeys, blue jays, cardinals, pheasants, quail and grackles have all increased at least twofold and some more than 40-fold in the past 25 years since the organic pesticides (including DDT) were widely introduced. Surprisingly, a number of raptorial species (hawks) which, being at the top of the carnivorous food chain, are alleged to being rapidly poisoned into extinction, have also shown that they are either holding their own or are increasing. Unfortunately, several do show a steady decline and include among their number Cooper's hawk, golden eagle and the peregrine falcon. These declines, however, appear to be more related to the encroachment of man's civilization upon their wild breeding and feeding haunts than upon the direct effect of any pesticide. Certainly the peregrine falcon was driven from the Hudson River escarpments by man's intrusion long before DDT. In many areas of the world this superb raptor has shown a decline regardless of whether DDT was used in its environment or not.

New habitats

The fish hawk, or osprey, on the other hand, though driven from its shoreline haunts on the East Coast has reinforced its numbers inland and a significant rise in the migration count has been recorded for several years at the Hawk Mountain Sanctuary Observation Post on the Great Appalachian Fly Way.

The brown pelican's serious decline on the West Coast is furiously blamed on DDT. On the other hand, he is flourishing along the Florida coasts where DDT has been used as much if not more than in California.

Conservation or conversation

Unreasonable public fear of scientific technology in general, and of agricultural chemicals specifically, gives rise to voracious criticism, but there is no point in banning pesticides until there is an equally efficient way found to do their job. Great strides have been made by the "Green Revolution" in producing food, clothing and shelter for billions of humans. Let's not negate these strides nor set an example for developing nations by hysterically restricting the use of pesticides.

There is no question that man's multiplication invokes a massive impact on the environment and impinges upon many of the wild creatures. Hopefully we can find a way to preserve and conserve both man and wildlife. Conservation is directed primarily at conserving man and those plants and creatures and areas which serve man: anything else is not conservation but merely conversation.

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THE ROLE OF PESTICIDES IN FOOD PRODUCTION AND HEALTH

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In the latter third of the Twentieth Century, which commenced incidently just this last fall, our nation and the world as a whole has entered upon the most challenging period in the history of mankind. We have only about thirty years remaining to meet and resolve the immense problem of feeding and sheltering a human population which will inexorably pass six billion and quite possibly seven billion by the year 2000 A.D.

With over two-thirds of the people present on earth today in a state of malnutrition and over half virtually at starvation level, the inevitable doubling of the population in the next thirty years can only result in a socio-political economic disaster of catastrophic proportions. Such a debacle in what we have come to regard as modern civilization will not suddenly occur like a bolt of lightning, but will appear, as Anson points out, here and there in patches, like festering sores, which will coalesce into vast areas of suffering the effects of which ultimately will extend into every quarter of the planet.

The incredible increase in humanity in the Twentieth Century which will aggregate more than three-fold the entire growth of mankind since humanoids first appeared on earth, is undoubtedly the most cataclysmic biological event since life first appeared on the planet. Man today is probably the most prolific mammal in existence and certainly exceeds the entire aggregate of his mammalian livestock.

The total emigration of Europeans to the Western Hemisphere over the past three hundred years is now roughly equalled by the annual increase in world population. This movement of the European peoples into North and South America, not foreseen by Malthus in his essays on population and food written almost two centuries ago, relieved the press of people in western Europe and is now virtually completed. The total of massive emigrations that are perhaps still feasible into the Western Hemisphere, Oceania and the sparse, inhospitable reaches of Russian Siberia could only accommodate the additional population of one, two or at the most three years of increase at the present rate, which is itself rising in compound interest terms.

Grain Production, the Indicator

In 1960, as Brown points out, the curve for world grain production was crossed by that for grain consumption, and unless measures are immediately taken to turn the production of grain sharply upward, the resulting stock "draw down" will convert the burden of surplus, so maligned in the 1950's, into a world-wide deficit by the 1970's. As grain is basic to all food production its balance of supply and demand is reflected in availability of all food everywhere, and it serves as a sensitive indicator in the total relation of population to food supply.

In western Europe during this present decade grain production has risen 2 1/2% per annum, while the population is increasing at only 1% per annum. This is substantial progress and has been reflected in a concomitant rise in the European economy. In Latin America there has also been an annual grain increase of 2 1/2%, a surprising achievement, however the population is climbing at 3% annually resulting in a net loss in general economic status. Around the world as a whole the net nutritional gap is widening at an alarming rate particularly with respect to protein supply. At the current population growth 35% increase in total food production will be required to maintain the present clearly inadequate diets, and a 50% increase is necessary to bring the total human diet to the minimum calorie-protein requirements established by WHO of the United Nations.

The Alternative to Required Food Increase - Chaos

To maintain such minimal diets through year 2000, total world food supply must be trebled, while among the underdeveloped nations where the deficiency is already acute, food production must be quadrupled and animal protein in particular increased six-fold.

Can these levels be reached by 2000? If so, how? This is the great challenge of our time and as we in scientific agriculture have the knowledge and the tools with which to achieve these goals it becomes our duty to do so.

Senator McGovern, in a recent article, raised the provocative question, "Shall we in America today be remembered, in the years to come, as the nation that preferred to expend their talents, their treasure and their opportunities upon sending a man to the moon rather than turning our knowledge, our power and our compassion upon the needs of mankind?"

Thucydides some 2500 years ago remarked, "Those who fail to learn the lessons of history are condemned to live it over again," yet modern man, despite his conquest of hunger in the Western World may again fail to note the lessons of history and apply his knowledge and power to satiate the the needs of his people and like so many preceding civilizations in the past descend once more into oblivion.

Food, the Basis of All Civilization

For starving people are apathetic; they lack energy and cannot work productively or efficiently; without work no products are produced and no products yield no income; without income capital investment is futile; without capital no start on the problem can be initiated. These submarginal peoples, to whom Malthus himself referred as "those, who in the great lottery of life, have drawn a blank," essentially lie beyond the pale of our society and outside the economic bloodstream of mankind. They are no more economically significant than are the wild creatures of the forest or plain, they neither add to nor detract from the course of world economy; but they are human beings and as such exert enormous social and political significance which in the close quarters of the world today modern civilization can no longer afford to ignore. They can and must be nourished, educated to primary literacy and put to work to produce their own food and fiber, to earn real income in goods and services which they can exchange for currency and other products from abroad. Then they will create new desires, new needs and new markets which can be supplied by industry and the vicious cycle of hunger, despair and want will be broken and the "take-off" stage reached.

Steps Needed to Increase Food Supply

The primary need is food and fiber and the first step that can be made is in gathering the maximum harvest possible within the scope of present practise and facilities, in preserving the harvested produce and in distributing it to wherever it is needed. In India for examp
Dr. Subramanyan of the Institute for Food Research at Mysore reports that over 50% of the food gathered from their very poor harvests fails to reach the desperately hungry because of the ravages of insects, disease and vermin. In India it would be possible immediately to increase the use of food now produced by almost 100% by merely protecting it, a function for which pesticides are largely designed. In addition harvested yields are absurdly low due to poor soil management, nutrient deficiency, insects, diseases, weeds and drought. Again within the present Indian farming procedures introduction of simple machinery to prepare the seed bed, modest dressings of as little as 300-500 lbs. of 5-10-5 equivalent fertilizer plus 500-1000 lbs. of lime per acre which would show substantial increases in yields, together with insecticides, fungicides and particularly herbicides and the simple hand equipment needed for their application, would, it is estimated, increase yields from 50-100% within 3-5 years. This might well be enough head start to lift many Indian farmers into the "take-off" stage, where they could then advance themselves to more effective plant and animal stocks, heavier equipment more agricultural chemicals and efficient storage and holding facilities.

Organized education, extension and demonstration become an essential part of this program, and the emphasis throughout must be self-help, self-production and self-achievement for only then will they develop pride in their work and their goals can be attained with astonishing rapidity. This is not an idle Utopian dream for Japan and Israel have already accomplished such objectives under perhaps even more difficult circumstances than those which today confront India.

The Role of the United States in the War on Hunger

The role that the Western World, particularly North America, will play on this attack on starvation will be in three phases:

First Phase - The filling of the gap for food deficient nations for the interim period of perhaps 5, 10 or even twenty years before the emerging nations can become fully self-sufficient. This will generate an enormous market for our farm proudcts, in turn creating strong demand for all agricultural inputs such as machinery, plant seed, animal stocks and chemicals. There will be some resistance initially to such an expansion of our agriculture for fear that food surpluses will again accumulate as the developing nations replace our food supply with their home grown produce. Although there may be some temporary surpluses of grain, soybeans, etc. these will be quite fleeting and with well planned scheduling they will not be of great economic significance. For we would export to needy nations primarily cereals, legumes and corn, which we can always condense into higher priced luxury animal proteins for our domestic market and for Europe whenever the supply of cereals exceeds the demand. In addition our own population will increase by at least 150 million during the next thirty-three years and in the 1980's we will readily consume any such surplus production potential from the 1970's developed to aid emerging nations through their first phase.

Second Phase - The emerging nations will need to educate and train their rural peoples to primary literacy, to train them in the elements of modern agriculture, to supply them with equipment, plant and animal stocks applicable to their region together with agricultural chemicals, to provide local elementary training centers with ancillary extension service similar to our own county agent system and to establish regional experiment stations and laboratories to resolve local problems. Here again the western countries will need to supply the equipment, the chemicals and initially the instructors to start the training of native teachers and to initiate the program. Within thirty years the emerging nations could take over the entire program of education, extension, field research and development and become self-sufficient.

Third Phase - With their people adequately fed and their lands productive the governments of these emerging nations can then embark on major projects involving irrigation, power production, light industry, improved transport and ultimately, where resources and markets permit heavy industry.

Actually each phase would merge into the next with no clear line of demarkation. Some areas within each nation will advance more rapidly through the phases than others.

Combined with such a program there will have to be some form of organized population limitation, preferably on a voluntary basis promoted through education, for no food production program, regardless of how efficient it may be can possibly keep pace with an exponentially expanding population. This is the major challenge and duty of the medical profession, the social scientists and particularly the politicians.

North America, the Last Great Hope on Earth

Precisely which form the program to meet the food and fiber needs of mankind will take in this last third of the Twentieth Century is as yet uncertain but one paramount fact is clear. The United States and Canada are about to meet the greatest demands both from at home and abroad on their ability to produce food in their history. The need will be immense for agricultural chemicals, for fertilizers and feed supplements to promote production of plant crops and livestock and for pesticides to suppress the incursions of predators and parasites upon the produced crops and animals both in the field and on the derived processed foodstuffs in distribution channels and in storage.

With this demand which can easily double the domestic market at home within a decade and double it again around the world, will come an increased pressure for pesticides that are effective, safe, practicable, stable, correctly formulated and packaged, economically valid and efficiently applied.

Pesticides, an Essential Factor

There may well be vast changes ahead in the control of insects, diseases and weeds, but it is quite certain that all such changes will involve the increased use rather than reduced application of pesticides.

In spite of the recent carping and criticism directed at the use of agricultural chemicals in the production of the nation's food and fiber and the maintenance of the public health, the indisputable fact remains that without these powerful instruments modern agriculture as now practised would be completely impossible. From 80 to 100 million people in North America simply could not be fed if we had to rely upon biological controls to preserve our crops, our livestock and our stored foods and fibers. Our standard of living would decline to intolerable levels and we would be unable to bring relief and succor to any other nation on earth. The destitution, disease and devastation that would descend upon every quarter of mankind would be virtually indescribable.

There will be, undoubtedly, many specific programs of pest control, particularly of insects, which will involve integration of biological with chemical control methods. Indeed this has been the general basis of control long before the advent of modern pesticides. Plowing down crop detritus to reduce carry-over of wintering spores, eggs or pupae, rotation of crops to hold down pest multiplication, destruction of alternate hosts, delayed seeding dates to escape infestation, release of predators, use of resistant varieties, plant location and spacing to avoid favorable pest environments, fertilizing and irrigating to reduce pest invasion all comprise biological control in the broadest sense.

Furtick points out that many of our present cultural methods were originally designed solely to reduce the competition of weeds. The two-way check row system of planting corn, for example, was designed primarily to allow for adequate control of weeds by cultivation, and the width of the rows and checks was based on the size of the rear end of the horse that would pull the cultivator. Now the introduction of the new herbicides entirely eliminates the need to cultivate some crops and has induced agronomists and practical growers to re-assess the spacing in many field crops in relation to optimum yields. Furtick contends it may well prove to be more efficient to grow many crops in virtually solid plantings like cereals rather than in rows, provided weeds, insects and diseases can be controlled either by preplanting or pre-emergent applications of systemic pesticides or by topical treatment from the air or in irrigation waters over the growing crop.

Certainly when our major crops can be successfully raised in an essentially weed-free environment, when our rangelands and pastures can be rid of the mesquite, unpalatable shrubs and non-nutritious herbs and grasses which predominate the vast reaches of our plains then the productivity of cattle, sheep and wildlife also will flourish. With the new herbicides available today we can now begin to realize this, and around the world the impact it would have on grazing animal production is immeasurable.

Biological Pest Control Only a Partial Answer

There will undoubtedly be an expansion of broad Federal and State programs to reduce insect pest populations by such biological methods as sex sterilization, attractants and predator release but these are highly specific and though they may materially aid the grower in reduction of pest contagion they do not offer his crop the total protection he must have to meet the demands of his market.

The grower must bring his produce and his livestock to market virtually unscarred and unblemished if he wishes to receive top price. Indeed in many cases he cannot market his crop at all if he does not meet the rigorous standards of freedom from insect or disease contamination required by the Federal authorities for grade labelling and interstate shipment. For the grower to attempt to fulfill such requirements and to rely solely upon biological or non-chemical methods would prove to be futile and economically disastrous.

McNew has recently noted that a number of major crop plants in the U.S. are attacked by as many as 50-200 pathogenic diseases, let alone insects. In the eastern states, for example, the important tomato crop is subject to 115 identified diseases of which 83 are fungi, 11 bacteria, 16 viruses and a number of nematodes; potatoes are subject to attack from over 200 known diseases, wheat 77, corn 112, apples 200. So far as is known there are no reliable biological controls for any of these pests. Fortunately probably not more than 20-25% of these pests are significant economic threats in any given season or area, but even this number is a formidable menace to any grower's livelihood.

In the Shenandoah Valley of Virginia, one of the great apple growing areas of America, the Virginia Polytechnic Institute Extension Department at Blacksburg, issues annually a brochure listing approved pest control recommendations for the production of apples and other crops. For the apple they list twenty-five major pests with which the grower must anticipate trouble in any production year. There is not even a completely reliable biological control for two of the insect pests and none for the several fungus diseases. Clearly if the grower must equip and prepare himself to use chemical methods to keep his crop free of twenty-three of twenty-five pests he might as well knock off the other two en route - he would anyway.

The Fallacy of the Target Pesticide

There has been much said in recent years about target pesticides. The argument advanced, in some cases by those who surely must know better, is that we should use a pesticide specific only to a single insect or at least to a closely related family of insects, such for example as the aphids. Such a pesticide would therefore kill only that particular bug and no other. In this manner it is claimed we would not harm beneficial insects or wildlife and thus not upset the so-called balance of nature. As expressed in a recent book we would "kill with a stiletto rather than a club."

The fallacy in this reasoning lies in the complete disregard of its impracticality. The Virginia apple grower, for example, would need to stock twenty-five different pesticides in adequate quantity and formulation. As many of these pesticides would require different methods of application he would also have to purchase several different types of equipment and keep them in working shape. He would have to be able to identify immediately each pest as it arrived and recognize the precise stage at which the specific pesticide should be applied. Finally, he would have to be well versed in chemistry in addition to horticulture, entomology and plant pathology so that he would know which chemicals can be mixed together or applied upon each other.

As all pests do not come singly and sequentially but in bursts of several at a time this grower might well find it necessary to go through his orchard two or three times a day applying first one chemical then another to catch each specific insect or disease in turn. Not only would this become fantastically impractical and costly, but he would rapidly wear out his equipment, abuse his trees and literally run himself into bankruptcy.

The probability of such a grower being able to thread his way through a season of such complex pest controls is so extreme that certainly any apple producer who successfully completed such an obstacle course would be entitled to at least $2 apiece for his apples, a price the urban house wife would likely be quite reluctant to pay.

In addition to this absurd predicament for the grower there are equally rediculous burdens such a target chemical proposal would lay upon the pesticide manufacturer and the State and Federal food control officials.

The manufacturer would have to invest essentially as much time, effort and facilities in researching, developing, formulating, registering and marketing a pesticide with but a single label claim as one which carried a hundred claims and uses. His prospective market however, would obviously be substantially limited, under present requirements for registration, to a point where recovery of investment would be a virtual impossibility. Furthermore, as formulations for various host plants often must differ it would be necessary to develop, manufacture, control, package, inventory and market a single pesticide in multiple formulations for a single pest for a single crop use.

The problems for the State and Federal control officials would also proliferate to prodigious levels as the application of twenty-five different chemicals to a single crop of apples would create insuperable difficulties in the monitoring of residues, and the number of pesticides needed to combat all the pests on all the crops in all the crop areas of the country would aggregate tens of thousands and require a staff of chemists several orders of magnitude from that of the present.

From these obstacles, plus the fact that it is quite dubious that it would be possible to develop a target specific pesticide for even every major pest, it is obvious such a proposal is completely absurd. It is true one or two such target pesticides have evolved, presumably more by accident than by intent. One is the remarkable compound RATICATE(R) -norbormide(5-(alpha-hydroxy-alpha-2-pyridylbenzyl)-7-(alpha-2-pyridylbenzylidene)-5-norbornene-2, 3-dicarboximide) which is apparently an absolutely specific poison to the Norway rat. Another is one Cyanamid has found and developed called ABATE(R) (0,0,0',0'-tetramethyl 0,0'-thiodi-p-phenylene phosphorothioate) which is highly specific to mosquito larvae. There may be other possible uses for this interesting phosphate insecticide and we are diligently searching for them, but at the moment, at least, it is registered only for mosquito abatement.

Objectives of the Agricultural Chemical Industry

The objective of the Agricultural Chemical industry is to find, develop and apply compounds which will be active in economical and practical formulations at sensible levels in dosages safe to the applicator, the host plant or livestock, the consumer of the treated product and to desirable wildlife; but at the same time with as wide a spectrum of activity against the pests as feasible. This applies primarily to insecticides and fungicides. With herbicides high target specificity is obviously highly desirable and useful.

Actually the newer pesticides do show a widening margin of safety at the effective pesticidal levels between invertebrates and vertebrates. The newer systemic pesticides, in addition, effectively discriminate between pests and beneficial insects for they only kill those which actually attack (bite, suck or chew) the host plant.

Industrial Research and Development of New Pesticides

The research and development of a new pesticide either for use on plant crops, livestock, waters, forests, rangelands or area control has evolved into a highly organized program involving a wide array of scientific disciplines, equipment and facilities. These are usually not directed at a specific pest but at general areas of problems, at least in the initial stages of a project. For it would be unwise for a company to select, for example, the European corn borer as a target, and marshal its staff and facilities for the sole purpose of isolating a compound effective specifically against this pest. Such would be an extraordinarily expensive, risky and probably economically futile course to pursue. It would be comparable to buying an automobile that could only go north or south and another only east and west, both being expensively useless.

Most chemical companies isolate new compounds from natural sources such as plants, soils, fungi, bacteria and animals or they synthesize them from other known compounds. These are then tested through a series of screens to determine their potential usefulness in medicine, in agriculture or in industry. When prospective utility appears then a more intensive screening is applied to delineate the precise nature both qualitatively and quantitatively for such possible application. Should a particular compound show interesting activity as an insecticide then of course a number of near relatives, or analogues, are also prepared to determine the scope of the activity in terms of molecular structure, and, hopefully, to find a particular analogue even more effective and useful than the original lead compound.

Following two or three years of intensive laboratory study, if the selected compound appears to hold up in crucial testing, then the synthesis is scaled up from grams to pounds and samples extended to the land grant colleges and experiment stations for field testing in areas where the pest sensitive to the compound is known to be endemic. Preliminary toxicology is first carried out to determine the toxicity of the new substance and to prepare necessary precautions for people who will research it further in the laboratory or the field. If after a year or two of field testing, the supreme court before which many new pesticides fail, the compound continues to appear useful, then the company begins intensive research to develop methods of assay both of the compound as formulated and of its possible metabolites or residues in the treated plant or animal; formulations are developed; long-term toxicology in two species of mammals is commenced to determine any possible injury that might result from consuming the compound; and studies into the fate of the compound in or on plants, animals or soil are carried out to determine precisely what happens to it after it is applied.

These studies together with those proceeding concomitantly at the field experiment stations usually go forward for at least 4-5 years and often to eight years. At any time during this long gestation period should some unexpected undesirable feature appear, such as serious side effects among the test animals on toxicity trials, instability of the compound in storage, explosive properties, phytotoxicity, excessive corrosiveness, etc. the product is promptly withdrawn and the project terminated.

When it is felt the evidence accumulated shows the pesticide to be safe, useful, economically valid and effective then the data are carefully collated into a report and submitted to the USDA for review of the efficacy evidence and to the FDA for review of the safety data. When all requirements are met then the new pesticide may be registered and a label claim allowed relative to the specific evidence provided. Each additional label claim must in turn be supported by equivalent and pertinent evidence.

Thus the entire course from invention to registration may occupy 8-10 years and represent an investment of from 2 to 3 million dollars.

The Pesticide Label - Industry's Ultimate Responsibility

The touchstone of this investment is the label which represents not only the condensed expression of eight years of intensive research and investigation by as many as 20-30 highly qualified experts but more importantly constitutes the instruction to and protection of the farmer who applies the pesticide and the consumer who without knowing anything at all about the compound eats the treated product.

It is obvious that in our complex society where foods may derive from many areas and become mixed or processed together that such public regulation broadly applied over all foods and compounds used in their production or preparation is essential. The consumer cannot possibly protect himself in such a complex for he has no knowledge where, or how or with what the food he buys has been treated, so he assumes in good faith it is safe to eat and that the government is indeed protecting his interests. Actually, of course, the State and Federal authorities can only set up the rules and standards and by random inspection and sampling maintain reasonable monitor on each kind of product from each major area. They cannot hope to check every product from every area all the time and the only real assurance the consumer can have as to the quality and safety of a product he may purchase lies in the integrity and responsibility of the producer. In turn this sense of probity is derived by the producer from those who supplied him with the raw goods and materials from which he made his product. This includes his source of pesticide and those who formulated and who helped to apply it.

Thus the manufacturer of a pesticide who after investing eight years of time and upwards of 2 million dollars in capital in his product would indeed be extraordinarily foolish if he failed to ensure in every possible way that his product would fulfill the needs, not only of his customer, but also of his customer's customers.

Importance of Formulations and Application

Regardless of the efficacy, safety, stability, versatility or economy that the manufacturer may build into a new pesticide it can often be diminished by unsuitable inefficient or inaccurate formulation or by inept and inefficient application of the pesticide in the field. Although it is

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true that no amount of good formulation or application can make an effective pesticide out of an inactive compound, it is also a fact that poor formulation or incompetent application can certainly impair the efficacy of an active pesticide. Just as the classical definition of an economic product is one that is in the form required, at the place required, at the time required and at the price required, so is a pesticide effective when it has the requisite activity, and safety, is formulated properly, is stable and is applied precisely where it can effect its required activity.

Only in recent years have we come to appreciate the importance of formulations and the method of application. Improved carriers, emulsifiers, spreaders, stabilizers and potentiators have all enhanced the efficacy of our pesticidal compounds substantially. This has proved to be a two-fold benefit. First, it has provided a more effective pesticide from which we now can get more mileage, but in addition it has, in many cases, widened the safety margin between the pest and man and animals.

The development of granular formulations with sustained release has materially improved the efficiency of the systemic insecticides and particularly the herbicides used for selective weed control in cereal plantings and rangeland or pasture management. Improved liquid emulsifiable concentrates, wettable powders and immiscible solutions ensure more uniform spread, prolonged adhesiveness and are particularly more adaptable to the variety of equipment and methods of application now available to the grower.

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Developments in Application

Although ground equipment still comprises the chief route of application on most crop plantings, as individual farms increase in area, as single orchards and vegetable fields become more extensive and as drilled crops, such as cereals, inaccessible forests and vast pasture and rangelands require pest control such relatively low-gear ground applicators become either impractical or uneconomical.

The use of aerial equipment planes, helicopters and the more recent air cushion applicators has and will continue to increase. Early attempts to apply pesticides from the air were fraught with complications and often with dissappointing results. Indeed perhaps the most violent criticism of the use of pesticides was primarily directed at aerial application. It was frequently contended, and admittedly with some justification, that the aerial application was largely a clumsy operation that lacked precision. It was considered, in short, to be the epitome of the indiscriminate use of pesticides. Drift, ununiform distribution, contamination of lakes, streams, waterways and even private property were repeatedly cited in opposition to aerial application of pesticides even of quite restricted areas. This opposition understandably crystallized into legislation strictly controlling the kinds and levels of pesticides that were allowable for aerial application, the type of equipment permissible and defined the precise conditions of weather during which spraying could be done. These regulations have reached the point in some states, such as California, where custom applicators must be examined and suitably qualified, and where each and every application must be registered with the county agricultural commissioner as to all details of where, how, when and with what a particular area will be sprayed before license to make the application is issued. In intensive crop areas as the San Joaquin Valley of California such absolute control is essential for the general protection of all farming areas, for irrigation canals could easily carry compounds to sensitive crops miles away from the site of treatment with serious results.

The recent development by the USDA of low-volume aerial application of insecticide constitutes a significant breakthrough in the whole scope of pesticidal treatment from the air. It was noted that concentrated solutions of the insecticide could be applied more uniformly with greater penetration into the plant canopy, with less drift and less evaporation than the conventional water diluted and dispersed emulsions. In addition substantial economies in the cost of application accrued as the area per payload increased 6-10 fold, with a concomitant reduction in fuel costs, reloading time and service expense. As drift was reduced the planes could fly four to five times as high above the canopy, providing a wider swath per pass and more importantly greater safety to the operator and neighboring people.

New pumping systems were devised to meter the pesticide accurately in ounces instead of gallons per acre, and also to provide virtually instantaneous cut-off control; special distributor nozzles were developed to spread the minute levels of the pesticide into swaths of controllable fine particles.

To date the bulk of the field trials have been carried out using the insecticide, Malathion, but there is every reason to believe that fungicides and herbicides as well as other insecticides can be prepared and adapted to the same principle of low-volume application.

There is considerable field investigation proceeding to adapt the L.V. method to ground equipment, where also considerable practical and economic advantage over conventional methods is anticipated.

A recent study has been initiated, stimulated presumably by the needs in the Viet Nam conflict, to apply pesticides, both insecticides and herbicides by the LV. technique at vastly greater heights (to avoid ground fire) than any regarded as suitable for crop, forest or rangeland treatment in this country.

Such improved efficiency in application of pesticides, together with more effective formulations and pesticidal compounds with superior activity and wider margins of safety all integrate into an increased capacity for modern man to meet his rising needs of food, fiber and public health.

The Importance of Pesticides Confirmed

In spite of the fierce criticism which assailed the agricultural chemical industry and the whole apparatus of pesticide utilization during the past five years the quiet assurance of those of us actively familiar with these instruments of modern agriculture has been reaffirmed and substantiated. There was never any doubt in our minds as to the relative benefit and hazard of insecticides, fungicides, herbicides and rodenticides. We knew from the start that, without them, this country could neither feed the bodies nor sustain the health of its people. We knew that if the

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present take of insects, disease, tares and rodents of some 20-25 cents of the food dollar were allowed to increase to 40, 50 or perhaps 75 cents as it is in India today, not only would our food standards precipitously decline but the quantity available would drop to below subsistence level. We knew that diseases such as malaria, yellow fever and typhus which scourged our people mercilessly for two centuries and which still hold great multitudes of humanity prostrate, would once again return to our shores after having been extirpated and banished for over a decade.

Now that the emotion and mindless carping has largely subsided, and after a dozen or more State and Federal committee reports have been issued the public realizes that the possible dangers of pesticides are understandable, assessable and therefore controllable while the perils they prevent are ubiquitous, unpredictable and devastating.

Pesticide Hazards Exaggerated

Even so there still appear spurious tracts and articles, obviously more attentive to circulation than veracity, which deliberately continue to seek to foment fear and consternation among the public over the exaggerated dangers of pesticides. In the current issue of a popular science magazine an article again reiterates the totally unfounded implication that pesticide residues, specifically the organo chlorines, are "the sinister companions of radio active nuclear fall-out." This type of pseudo scientific mixed metaphor can only be contradicted by experimental objective evidence of which there is, fortunately, an abundance.

The Hayes, Simmons, Knipling monograph on DDT, published in the early 1960's, and incidently completely ignored by Longgood, Herber, Carson, Hueper and other self-appointed custodians of the public welfare, is the most exhaustive and complete documented collation of the scientific literature prior to 1961. There it is clearly indicated that relatively persistent, and usefully so, as is DDT it has a measurable half life in the biosphere which reduces recommended applications below pharmacologically significant levels quite rapidly. The authors clearly annotated that even immediately following normal rates of application deposited concentrations of DDT are generally innocuous to virtually all forms of vertebrate wildlife including birds, with the possible exception of certain species of fish. When one stacks up the injury to humans that encephalitis can do where uncontrolled mosquitoes are allowed to spread it at large, one is tempted to ask how many human babies is a mud puppy worth.

Hayes' long-term studies on the effects of continuously ingested DDT by human volunteers clearly showed that chronic dosing at levels from 20 to 40 times the maximum allowable residues in our foodstuffs, and some 900 times higher than the average intake level in 1962, elicited no measurable clinical effects. Since these classical trials the FDA has repeatedly made market basket surveys in numbers of cities to assess the probable total intake of organo chlorine residues from all sources and finds the total remains below 1% of the allowable tolerance. Corresponding assays of DDT and related chlorinated hydrocarbons in human fat, where it tends to pool, show no increase in storage over the past fifteen years, again giving the lie to the ominous and unfounded predictions made a few years ago and still implied in popular articles today.

The inexpiable furor over the Mississippi River fish kill is perhaps as good an example as any of how inexorably fact treads upon the footsteps of fancy. The first notice issued to the press was that the kill was caused by surface wash off and drainage of the pesticide treated cotton fields of the Delta; but when it was shown the primary drainage and tributary streams carried a level of organo chlorine actually lower than did the main river, the cotton farmers became exonerated, albeit in the back pages of the press. Then a pesticide manufacturer near Memphis was accused as the culprit, but the fact that the kill took place some 700 miles downstream promptly downed that explanation. Furthermore, there was no reported severe kill of shrimp and the shrimp, being more closely related to insects than to fish, would have been virtually extinguished if the fish kill had actually been due to chlorinated hydrocarbon pesticides.

Ferguson at the University of Mississippi examined the tolerance of Mississippi fish to various organo chlorines and found they survived at levels over a 1000-fold that measured in the water of the main river.

Later a more logical explanation was the overwhelming invasion of the area by a gill disease which is particularly injurious to bottom fish.

Since the days of the Mississippi fish paralogism the USDA has been carefully monitoring the waters of the main stream and the soil detritus beneath and to date they find no evidence of a sinister accumulation of lethal pesticides.

Perhaps the most curious denouement of the whole fiasco was that at the very time of the wide and fearsome publicity on alledged pesticidal fish kill in the Mississippi River, the USPHS published an official report on the unnatural fish kill in the U.S. and ascribed a shade of 1% of the total nationwide loss to pesticides. In one year they noted improper processed sewage was responsible for over 50% of the recorded unnatural fish kill - 50 times that ascribed to pesticides.

Despite the extravagant claims that pesticides are steadily draining away our wildlife, particularly birds, there is abundant evidence from all areas of the country that wildlife especially bird life is flourishing. The annual Audubon Christmas bird count, described by its founder Dr. Cruikshank as the most complete and reliable bird census in the world, and whose recorders Carson referred to as "having an unparalleled knowledge of bird life in America" shows no general decline in bird life.

Precise animal count data on a large scale in the Yosemite Mountains to assess the impact of general spraying of Malathion to control an invasion of the lodge pole pine needle miner revealed only a momentary (30 day) but insignificant reduction in birds following the spraying, with a subsequent return of even greater numbers of birds within a year.

Although it has not been critically assessed the available evidence to date would suggest that bird life in general may be actually increased rather than destroyed by the protection provided by generalized forest and rangeland spraying of pesticides as a consequence of the resultant reduction of insect vectored avian diseases and the maintenance of the verdure for feeding and nesting facilities.

Agricultural Chemistry - the Key to Future Abundance

As we approach the turn of the second millenium we must prepare for the burgeoning human population that is unlikely to be stabilized this side of 7 billion people. If our civilization and socio-political organization is to be sustained and hopefully improved we shall have to provide food and shelter and health for these billions or only chaos will prevail. Chemistry is the key to the provision of the necessary abundance of fruits of the earth in terms of conventional farming and particularly will chemistry guide us in the very likely event that we must turn also to such unconventional methods of food production as aquiculture - the culture of plants and fish in the marine and inland waters - fermentations of waste sources of energy such as foliage, sawdust, bagasse, cannery wastes, petroleum waxes and even sewage wastes and perhaps ultimately should we need to synthesize fats, carbohydrates and elementary proteins from atmospheric elemental sources.

One inescapable fact is certain, although the challenge to our generation is vast and global in extent and although the time remaining to meet it is rapidly expiring, it is not insuperable for we now have the equipment, the facilities, the materials and above all the knowledge to fulfill this great task. Should we become inclined to dissolve in a council of despair we might once again turn to the words and thoughts of Thomas Malthus, which after two centuries remain tenable and perhaps more confident in tone than does our own philosophy of today.

"At Nature's mighty feast, none are bishops, but all are men; there is no distinction; all that are invited are at liberty to partake, and the life of the guest is sacred; to be invited to the same table implies equality, and to possess life is to possess the invitation. The table is not spread by any set of men, they only pluck the fruit; the Master himself presides, and all he invites are equally welcome. Nor is it the prerogative of one guest to dismiss another from the hall of life; the Master calls on whom he will to vacate a seat, and his voice is irresistibly heard by all."

"Has then all the fruit been gathered? When it has, then, perhaps, will be the time to charge our Maker with folly until the uncultivated land has been brought under the plough, and the exigencies of Nature taxed to extreme, it is improper to say the bounty of Providence is not equal to the wants of man."

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THE FACTS AND FALLACIES OF SILENT SPRING

by

ROBERT WHITE-STEVENS

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THE FACTS AND FALLACIES OF SILENT SPRING

Robert White-Stevens[1]

By far the most significant problem facing man today, as it has been since time began, is the production of food and fiber to meet the necessities of life. For even with the so-called food surpluses which currently plague the Western world, if all the food of the world were divided equally among the peoples of the planet, we would all be in a state of semi-starvation.

Furthermore, the situation is becoming increasingly acute, for, as Thomas Malthus predicted nearly a century and a half ago, the population, despite wars and disease and famine, continues to increase geometrically, while the food supply has increased only arithmetically except in the Western countries, such as America, where science has been applied intensively to agriculture for the past hundred years and has resolved the problem.

The population of the world has now passed three billion, and is increasing at an incredible 55 million per year (almost 7000 per hour). These burgeoning billions are by no means confined to the countries of Asia and Africa, for in North America our population will pass 400 million by the year 2000. The arable land for food production will fall below two acres per person in North America and below half an acre per person for the world as a whole.

It is obvious that this presages catastrophe for our type of civilization unless food and fiber production can accelerate to meet the demand. We will, in fact, need to produce a world-wide "food explosion" to meet that of the population. Such has already taken place in North America during the past fifty years, and it can readily continue at an accelerated tempo if scientific research is allowed to progress unimpeded. For this century may well be the crucial turning point in man's long struggle against hunger and want. In former times man had neither the scientific knowhow nor the time and equipment to search for and develop such knowledge; in future years his burgeoning numbers may so overwhelm him that he will again be unable to organize his activities and facilities to achieve a margin of time and effort, above that needed for bare subsistence, to maintain progress in the arts and sciences and, of greatest import, the education of youth.

For the political-economic impact of the struggle for the bare necessaries of life has been gaining increasing momentum over the past half-century, and the international unrest and tensions of the present are a reflection of the strain between availability and need for food. The tension will clearly increase, for when men approach hunger they have nothing to lose and gain can be the only reward of survival. A Russian proverb says "A hungry belly knows no law."

M. C. Chagla, Indian Ambassador to the U. S., has stated:

> "I want you Americans in your land of plenty to imagine what it means for tens of millions of children to be born who will suffer from malnutrition, who will have no homes to live in, who will have no employment when they grow up, if they grow up, and who will spend their entire lives as disgruntled, envious and embittered human beings—a ready prey to any idea, no matter how monstrous, which might promise them surcease from their squalor and escape from misery, a hope for better prospects and a life more tolerable to live."

Mr. Chagla has described, from his own first-hand experience, the fertile ground in which the seed of communism and anarchy can germinate and flourish, and has remarked the basic cause of political unrest among the seething masses of southern Asia. Similar conditions are developing rapidly all over the world, and touch our very continent in Central and South America today. These hungry peoples no longer regard want as inevitable, only as intolerable, and history teaches us that hunger and war are sequential.

Even in America our population is increasing at a rate calculated to remove our politically embarrassing food surpluses in but a few years. To feed this population in the United States, we shall require by the year 2000 an additional 400 million acres of arable land, assuming we can maintain our present yields and productive efficiency. As we do not have such arable acreage available, we must turn elsewhere to meet the inevitable demand to be laid upon us. Alternatives include extending our hegemony over foreign and probably already overcrowded lands, a course repulsive to our very national ethics, or embarking on an intensive population control plan, a matter of great political and spiritual controversy, or turning to science and research and unquestionably expanding our food and fiber production far beyond the furthest reaches of our present horizons. We are, in fact, doing this now, for our food production is currently increasing as rapidly as our population.

In this land of apparently interminable surpluses, we have become not only physically surfeited but complacently apathetic about our food supply. The relatively small cost of our surplus is today a major political issue. Yet it is really a minor expense for the insurance it bestows upon the income of the farmer and the cost of food to the consumer. A five percent food surplus costs the nation only a fraction of what a similar deficit would cost the housewife in increased food prices.

The Biblical Joseph prepared a stored surplus of grain to meet the needs of ancient Egypt for the seven lean years, and has been thought to have possessed timeless wisdom for so doing. Today our food surplus would hardly carry us for seven lean months, and if used to feed the hungry peoples around the world, it would be exhausted in less than two months. Thus even with our proficient agriculture and our surplus abundance we are, in fact, not more than a year or two at the very most from starvation right here in America. This, then, is the frame of reference within which any major factor affecting agriculture must be viewed.

Recent surveys by the Foreign Research Service of the USDA in collaboration with the Food and Agriculture Organization of the United Nations have revealed that the total food deficit is not overwhelming, being some 46 million metric tons of protein-calorie equivalent. This could actually be met by achievable increases in the U. S. and Canada alone. Vast as is this deficiency, and enormous as is the human tragedy it creates, it could easily be resolved in the world as a whole within the next decade if we could apply the knowledge, equipment, supplies and techniques available today.

It is here and now that DeGraff's Law applies and can be realized: "The progress of a people is inversely proportional to the time and effort they must devote to their food production."

In ancient days the culture of peoples rested upon conquest, subjugation and slavery of their fellow men; today it can rest on science, to the benefit of all. This is the greatest victory, by far, that democracy has won, and for the peoples of the West, it is the prime margin of safety and security in an envious world.

In America today we provide our people with the greatest volume of highest quality of foodstuffs, in wide array at all seasons of the year, for an expenditure of only one-fifth of their work effort, and we do this with less than 10% of our work force. This allows 90% of our people to devote 80% of their productive time and energy to education, to research, to industry, to cultural pursuits and to aiding their fellow men, both at home and abroad, to achieve a more comfortable, productive, secure and contented life. The work of these non-agricultural peoples is what has made our nation great, but their release from the duties of food production has also inflated our urban and suburban centers, where a whole new generation has grown up without any understanding of farming and agricultural science or of what they have contributed to their own welfare. Food, and cheap food at that, can readily be obtained any time at the local supermarket, so why worry about the problems of insect and disease control, of fertilizers and soil management? Most urbanites, of course, don't worry about them or even give them a thought.

Now, however, we find that a whole series of attempts is being made to shake the confidence of the urban consumer in the safety of our food supply. Wild and fearful publicity has been deliberately fomented among the consumers of our country, calculated to sweep away the trust, assurance, and honest thinking in the business of agriculture and food production that it has taken our agricultural colleges, experiment stations and industry nearly one hundred years and untold effort to establish.

This criticism, essentially destructive in tenor and intent, is based on half-truths, scraps of irrelevant and unrelated evidence, much of it taken out of context and out of time and largely founded upon superstition and outright falsehood. The net effect has been to incite fear and consternation among the consumers of America out of all proportion to any possible or real danger involved.

It is against agricultural chemistry that the major barrage of attack is lodged, ignoring the facts that without agricultural chemicals fully one-third of our people couldn't eat, that pesticides have saved more lives than all the wonder drugs combined, that these chemical tools in our agriculture have provided us with an abundance of food of highest quality and safety for the lowest cost of any country in the world today, and that without pesticides the insects and diseases and vermin would once again inherit the earth.

The most recent outburst in this sorry repertoire is the book *Silent Spring* by Miss Rachel Carson, portions of which were published last summer in The New Yorker magazine. It is clearly indicative of the general missonception and misunderstanding among urban peoples concerning farming, food production and agricultural science that mail response to the articles aggregated 99:1 in favor of Miss Carson's viewpoint. It is also somewhat sobering to realize that these same urban peoples have the controlling vote and can, therefore, if sufficiently aroused, propel legislation through Congress which could literally shatter the advance of American agriculture, and with it the entire scope of our civilization. It would not be until after the damage was done, and the insects and diseases had boiled back to depress our food production and raise its cost by a factor of perhaps five, that the incredible damage to our total economy would be fully recognized. To paraphrase Mark Twain, this is really a case of free speech allowing someone to cry "Fire!" erroneously in a crowded theater.

Turning to the book *Silent Spring,* there is no doubt that Miss Carson is a writer of biological subjects with an extraordinarily vivid touch and elegance of expression. She writes with convincing indignation, and will undoubtedly assemble a prodigious following of supporters for her crusade.

Miss Carson's philosophy is straightforward and plain. She contends that the balance of Nature is essential to the well-being of all life, including man, and that man is deliberately and knowingly disturbing this balance by his introduction of new and unnatural chemical entities into the biosphere in volumes and distribution which are not governed by a rationale based on biology and the public welfare, but by reasoning evolved from temporary expediency and immediate profit. She contends that irrevocable damage has already been committed in many areas, and cites a long roster of carefully selected and edited examples to support her contention.

Apart from the scientific errors, misquotations and obvious misinterpretations with which her book is littered, the major area of disagreement between Miss Carson and students of applied agricultural chemistry will lie in her deliberately misplaced emphasis. She discounts and deliberately depreciates all those safety measures which research has laboriously developed and built into each new agricultural chemical that emerges, while she concomitantly builds the possible and alleged hazards of these compounds to horrible and staggering dimensions. This is, of course, an old dodge among writers who are more interested in an emotional response among their readers than in a balanced, objective understanding and judgment of the problem presented. In short, she frets over all possibilities of harm rather than assesses the realistic probabilities of hazard in the use of chemicals in agriculture.

For Miss Carson this kind of writing is clearly a new experience, and as she proceeds deeper into her narrative, her biological training and scientific background begin to disturb her conscience. When she comes to the exceedingly muddy and ill-defined area of alleged possible carcinogenic and mutagenic properties of agricultural chemicals, her writing lapses in self-defense into a series of rhetorical questions, "maybes," "mights," "possibilities" and generally evasive suppositions, which certainly leave the inquiring reader as doubtful and as confused as the author herself appears to be.

The basic difference between Miss Carson's concept of agriculture and that of the modern scientific agriculturist lies in her devotion to the beauty of Nature and life in the wild; the agriculturist addresses himself to the economic production of food and fiber for the burgeoning peoples of this earth, even, if necessary, at the expense of Nature in the raw. But suffice it to say that Miss Carson has written a significant piece, if for the sole reason that it will smoke the agricultural chemists out from their laboratories and conference rooms and force them to justify their *raison d'etre* before an aroused and justifiably curious public.

Miss Carson states: "Living creatures are adapted to natural molecular configurations by long-term exposure and genetic adaptation. New chemicals having no analogous counterpart in Nature allow no time or opportunity for living systems to adapt, produce antimetabolites, etc., and are therefore 'poisoned'."

The production of new natural molecular configurations occurs continually in myriad forms and places. Nature far exceeds man in the synthesis of new chemical forms. Most of these may well be but minor modifications of their parent molecules; others may differ radically in form and function. This is the biochemical basis of evolution.

Because a new compound emerges from a living process, it does not necessarily mean that it is more tolerable and less toxic to all living cells, even those of remote species. If a new molecule within a living creature is toxic to it, it becomes a genetic recessive and may even be a lethal gene; if it is not toxic to its host creature, but toxic to competitive creatures, it may become a new force for survival added to the arsenal of its parent.

Similarly, new molecular products of the synthetic chemist are just as likely to be toxic or innocuous or beneficial, depending upon the host, the use and the dosage. The mere fact that man made a new molecular compound before it appeared in Nature in no way means that it can play no useful role among living things. After all, it is quite possible that Nature may have already made the compound and long since discarded it, or perhaps Nature would have made it eventually.

The suggestion that living creatures cannot adapt to the presence of unnatural compounds in their environment is obviously specious in the light of the rapidity and ease with which many plants and animals do develop resistance to new insecticides, fungicides, antibiotics, sulfonamide drugs, etc., which capacity Miss Carson herself emphasizes and employs as a argument for the futility of pesticides. Such resistance does not arise by mutation but simply by the selective effect of the compound upon a population which already contains within its germ plasm the genetic components of resistance. As the compound kills all those individuals in the population that do not possess the resistant trait, those which live emerge as the remaining population and are resistant. In such cases, Nature has anticipated man's test tube and has prepared adaptation in advance.

Miss Carson contends that, because of the insect's ability to adapt rapidly to new chemicals and develop resistance, "a process of escalation has been going on in which ever more toxic chemicals must be found."

Although a continuing search for increased specific toxicity against insects is in process, there is also a continuous effort to widen the margin of safety between insect control and vertebrate toxicity to allow more effective control of insect pests with less collateral side-effect, for example malathion, which is equally as toxic to many insects as DDT and is about one-sixth as toxic to vertebrates. Sevin is another similar compound with a wider, not narrower, margin of safety. Safety tests have been increased several-fold over the past twenty years and are continually enhanced as knowledge and techniques in the related disciplines expand.

Miss Carson relates the alleged dangers accruing from the use of insecticides to those to be anticipated from nuclear war. She implies that pesticide chemicals now in use "accumulate in the tissues of plants and animals, and even penerate the germ cells, to shatter and alter the very material of heredity, upon which the shape of the future depends." She recognizes (conveniently) that "the results, of course, will not be apparent for decades or centuries." She contends that "all this has been risked . . . to control a few unwanted species of weeds and insects by a method [that brings] the threat of disease and death" to man.

This incredibly unscientific assertion that the biological activities of chemical pesticides now in current use are comparable or in any way related to those of such radioactive components of nuclear fallout as strontium 90, cesium 136, iodine 131 or cobalt 60 is totally unsupported by the evidence at hand. There is considerable evidence that radiation at appropriate levels may elevate the normal rate of mutations in a given species. There is no evidence that any one of the insecticides, fungicides, herbicides or rodenticides in current registered use evinces such activity.

It cannot be categorically stated that none of the agricultural chemicals now employed on foodstuffs are non-mutagenic on all species of life at all doses over all times of exposure. Such proof would require infinite time for experimentation and virtually infinite numbers of test animals. It can be said that no authentic evidence of mutagenic properties of any registered agricultural chemical has, as yet, been reported.

The few "unwanted" species of insects, fungi and weeds, which Miss Carson implies are not worth the risk, represent man's major adversaries in his struggle for food, health and shelter, and comprise the greatest scourges of mankind and his domestic livestock. Even with the control employed in North America, to which Miss Carson eloquently objects, these "unwanted" pests cost upwards of $15 billion per annum in our food and health bills; around the world the cost varies from two to perhaps ten times the U. S. rate of loss and, of course, is the prime factor in the gross starvation, associated disease and early death of over 50% of the world's human population. Evidently Miss Carson considers these humans in the "unwanted" class, in place of the few insects and weeds she would prefer to sustain.

Miss Carson conveniently ignores the outstanding examples of how pesticides have rid great areas of the world of such pestilences as malaria, yellow fever and filariasis (elephantiasis), with malaria reduced from 78 to 5 million cases per annum in India alone and the average life span of the East Indian increased from 32 to 47 years over the past decade and a half.

Miss Carson contends that if a few species of insects threaten man's food supply and his health, it is really his own fault for concentrating his food production into large areas and allowing his population to become so crowded and dirty that insect-born diseases can be rampant.

She recognizes that the development of pesticides is "an accompaniment of our modern way of life," that "insects inhabited the earth . . . long before the age of man," that they are "a group of extraordinarily varied and adaptable beings," and that only "a small percentage of more than half a million species of insects have come into conflict with human welfare . . . as competitiors for the food supply and as carriers of human disease."

She depreciates the developments of modern man, suggesting that the maintenance of the primordial balance of Nature in favor of insects—which clearly had the priority—would be preferable to the world-wide dominance of modern man. This exceedingly debatable point on the philosophy of life is perhaps largely a matter of opinion, but given the fact of burgeoning population of humans demanding an increasing amount of food, living space and longevity, there is an understandable inclination for man to meet the current needs of his own kind, even at the expense of other forms of life, and, particularly, pestiferous forms. I think it would be reasonable to expect that the insect or rodent world would take the same attitude towards man if given the intelligence to evaluate it and the physical means to exercise such power. A single flight of locusts can weigh 50,000 tons and, consuming its own weight in food daily, takes the food of 5 million humans per day.

Miss Carson contends that modern agricultural science "idealizes life with only its head out of water, inches above the limits of toleration of the corruption of its own environment," asking "why should we tolerate a diet of weak poisons, a home in insipid surroundings, a circle of acquaintances who are not quite our enemies, the noise of motors with just enough relief to prevent insanity? Who would want to live in a world which is just not quite fatal?" She contends that "such a world is pressed upon us. For the first time in history virtually every human being is subjected to contact with dangerous chemicals from birth to death."

It is perhaps here where the righteous wrath of Miss Carson and her co-thinkers is centered. There is a certain paranoic frustration that understandably ferments in our minds when we feel supposedly harmful and injurious forces pressing upon us from our surroundings, particularly when without our permission. It is perhaps akin to taxation without representation. But this is the story of life; we cannot exist on this planet without exposure to danger, both inanimate and animate, every second of our days.

As all life is biochemical and all matter chemical, we are continually exposed to chemicals, both internally and externally. They may be beneficial, innocuous or deleterious. By far the greatest number of specific chemical entities (molecular configurations) to which we are exposed are of natural origin, as opposed to pure synthesis by man. Nature develops new molecular groupings very much faster than does man. All of our diets are "contaminated" with foreign chemicals, regardless of how, where, when and by whom grown. Under so-called "natural" or "organic" methods of food production, contamination will be microflora, such as bacteria, fungi and small animals such as protozoa and minute worms, and by macrocontamination from insects (eggs, larvae, body parts, frass), rodents (excreta, hair), etc., as well as by many inorganic contaminants such as rare earth metals, gross metals, salts, oxides, etc. By far the majority of these contaminants are either harmless per se or are present at harmless levels. Whether serious "poisoning," infection, or sickness develops in the human or domestic animal consumer will depend entirely upon the rate and frequency of ingestion of the affected foodstuff, together with the rate of accumulation, metabolism and excretion of the toxic principle from the host. Precisely similar considerations apply to chemical contaminants appearing in human foods as residues from pesticide programs in the field. One important difference, however, lies in the fact that today we have a vastly greater knowledge of the dosages, metabolism, fate and pharmacology of the applied pesticide chemicals in our foodstuffs than we have of the fortuitous contamination by disease, excreta, and tissue fragments which inevitably occurs in appreciable degree among footdstuffs where no pesticides have been employed to control bacterial, fungal, insect, rodent, and nematodal invasion.

The real question, then, that Miss Carson should ask is not "Why should we tolerate a diet of weak poisons?" but "How can we prepare a diet wherein the 'poisons' are known, understood and controlled at an essentially harmless and innocuous level?" We must of necessity have it one way or the other, either the uncontrolled contamination of the unknown chemicals of Nature or a sharp reduction of these unknown natural chemicals and their partial replacement controlled minuscule amounts of "artificial" chemicals of known biological activity, fate and hazard.

Whether Miss Carson likes it or not, our world **is** a fatal one for all of us, and the singular contribution of science, including chemistry, has been to reduce the immediacy of fatality for the many and to improve significantly the experience of life for man in the prolonged interim. Science has not exposed man from birth to death to toxic chemicals; all life is thus by order of Nature. Man has merely grown to understand the form of some of these chemicals and their relative hazards and has replaced some with others of less toxicity and more ease of control.

Miss Carson cries out indignantly over the alleged contamination of the domestic water supply in the modern U. S. city. Let her then try the cholera-laden waters of the Ganges in India or the Huang Ho of China, the amoebic dysentery-filled ponds and streams of New Guinea, Indonesia, or Mexico, the parasite-polluted waters of the Nile and the Tigris and Euphrates; at least our "contaminated" waterways are free of infective levels of disease and the chemical contamination is known and under control.

I venture to think that the average American would prefer to ingest 1-2 parts per million of DDT in his butter than unknown levels of insect parts and excreta; he would rather ingest an innocuous dash of a rodenticide in his breakfast roll than an appreciable level of rat urine and feces. Presumably in a free democracy one may make one's own choice, and some do by consuming naturally-contaminated, organically-grown, pesticide-free foods. The considered judgment of the American people, however, expressed through laws prepared by their representatives in Congress and administered by Federal and State officers appointed to the purpose, has been to effect a reasonable compromise based upon scientific evidence assembled by research workers expertly qualified in the related disciplines. This compromise involves, on the one hand, setting up qualitative standards of purity, grade and sanitation for the produced food and, on the other hand, permitting allowable tolerances, methods and times of use of registered compounds of known composition, pharmacology, toxicity, fate and metabolism where such compounds are necessary to control the natural contaminants that degrade foodstuff. Following exhaustive studies over the past fifty years by Federal, State and industrial research workers, virtually every major foodstuff moving in commerce today in North America is classified with respect to its grade requirements, and every registered chemical used in or on such foodstuffs has met stringent requirements of purity, manufacture, safety, efficacy, compatibility, metabolism, pharmacology, toxicity and residue tolerance.

The result of this intensive, exhaustive and objective study of all our major food products and the factors employed to produce, process, store, distribute and market them is that today we have the largest amount of the best quality foodstuffs in greatest variety at all seasons of the year, with by far the highest level of purity, safety and nutritional components, and all of it for the least expenditure of labor by the people (20¢ of the take-home dollar) of any nation in man's long history of tedious, tragic and at times futile struggle against hunger and want.

But Miss Carson appears to resent modern man's being more interested in MASTERY than MYSTERY. One cannot completely quarrel with her concern, for there does seem to be some inexorable ingredient built into all man's civilizations which carries the seeds of destruction. This was true of Egyptian, Chinese, Indian, Greek, Carthaginian and Roman civilizations of antiquity, and can be noted in the rise and fall of great powers in the intervening centuries. In our time we add a new ingredient, science, and we hope it will enable our civilization to survive where others have failed. Perhaps it will if allowed to exercise its sway by rational and objective, rather than subjective and emotional, means.

There can be no doubt that the scientific mechanism of our civilization carries developing dangers for our future generations, but chemical pesticides are of minute and insignificant consequence among them. The incredible dangers to mankind and all life of the uncontrolled and irresponsible release of nuclear energy are real hazards to the future welfare of the human race, compared to which the imaginary horrors of Rachel Carson's chemically contaminated world are quite insignificant.

Even Miss Carson herself, after running the gambit of horrible hallucinations, finally agrees that the use of some chemicals for the control of intolerable pests is allowable provided they are used with sense, safety, and without abuse. This, of course, has been the general purpose all along. There have been abuses, yes, but these are quite the exception, and certainly abuse calls for censure and discipline of the abuser rather than banishment of the tools employed. A traffic accident calls for the trial and punishment of the guilty driver, not the destruction of all automobiles. Similarly, abuse of pesticides calls for discipline of the user who failed to follow label recommendations, not punitive action against the compound and its manufacturer.

The Federal and State laws, the constant research and extension by colleges, experiment stations and industry, and the general economic proficiency of the American farmer himself have, in the main, sustained a remarkably safe and logical balance between the productivity, the purity and the safety of our foodstuffs.

But the basic theme in Miss Carson's book is the alleged disturbance in the balance of Nature by agricultural chemistry, which she contends is the real long-term hazard to man. In the opening paragraphs of *Silent Spring*, she attempts to paint and Elysian picture of an imaginary American village of former years, composed of all the desirable features of Nature and at once free of all "evil" forces, wherein "harmony" reigned interminably, at least until chemicals descended upon it and rapidly reduced it to corruption, misery and death.

This delightful illusion of peaceful communion among living creatures is often the happy hallucination of the Naturalist. Although the so-called balance of Nature does exist wherever life abounds, this balance is red of tooth and claw and is ruled by certain immutable natural laws, such as the survival of the fittest, the normal distribution of populations, the independent segregation and recombination of certain inherited factors and the close linkage and dependence of others, the mutagenic impact of physical forces such as temperature, sunlight and cosmic radiation, and the incessant cycle of all life—birth, growth, reproduction and death.

Nature sustains the balance of life through these forces in a completely objective fashion; she favors none, she excludes none, she embraces all with equal attention. Nature shuffles her genes at each mating of each species with a detached indifference as to the outcome, dealing her assortments of genes upon the world in prolific fortuity, but always requiring each to pass through the screen of the survival of the fit, to which Miss Carson refers with admiration as "a triumphant vindication of Darwin's principle." Here the great mass is filtered out, and only a supreme few of each species are allowed to cycle on to the biological privilege of their own reproduction.

From Nature's standpoint, this is a superb method for advancing the course of living things, and when combined with the elegant symmetry of the normal distribution it generates the timeless evolution with which our planet is so indelibly imprinted.

This fortuitous shuffling of life's stuff and the rigorous screening of the issue of reproduction applies to all living forms, from the primary protoplast up the scale of biological complexity to man himself.

For in the harmony of Nature man is not a bystander but an integral part in the show of life; he is not, as some Naturalists would lead us to believe, the chosen beneficiary of Nature's munificence. Man must contest in the tourney of life as vigorously and as effectively as any other living creature or he will not survive.

This being the case, and as Nature gave him the biological advantages of intelligence, upright gait, chiasmic vision, vocal communication, opposable thumbs and a general ascendancy over his fellow creatures, so man fulfilled his destiny and emerged, for the time being at least, as the dominant form of life on this planet.

Man's dominance arose not because he continued as a passive player on Nature's stage but because, by exploiting his few biological advantages, he exerted his hegemony over other forms of life, gradually at first, then with accelerating momentum, until he usurped control over large areas of Nature's balance itself. As man's knowledge and power grow, he will continue to extend his rule over increased areas of Nature's dominion until, presumably, he will essentially control the entire functions of the planet, both physical and biological.

To the true Naturalist, this predictable scheme of the shape of things to come is understandably disturbing, for there is no question but that the rough beauty of Nature in the wild in an inspiring and stimulating experience. It is a joy which modern civilized man fully recognizes and indeed cherishes to a greater extend perhaps than his less enlightened brothers, who are still too closely locked in the eternal struggle with Nature for the bare necessaries of subsistence and survival to achieve a detached view.

For man himself has upset the balance of Nature by the gross pressure of his own numbers, and in any reestablishment of the natural equilibrium, it is man who must be first curtailed to some considerable extent. On the North American continent alone the imbalance has already reached the stage where any return to the idyllic, natural, so-called organic way of life is not possible unless the human population is reduced to perhaps a tenth of its present size. It goes without further comment that such a proposition is quite unacceptable to the nine-tenths to be marked for extinction.

When Columbus first discovered North America for Europe, the human population was perhaps between one and two million, and was in reasonable balance with Nature in this area of the world. It might be a matter of opinion as to whether such a situation was ideal from the human standpoint but from Nature's point of view it was in fine balance, and had been so for perhaps several thousand years.

Then immigration commenced, imperceptibly at first through the 17th and 18th centuries, but growing to a human tidal wave by the 19th and 20th centuries, and the human imbalance of Nature in Europe, which had flourished through earlier centuries to almost irrepressible limits, then burst upon the eastern shores of America and spread its pressures inexorably across the land to the Pacific.

In less than three hundred years—ten generations—a land which comfortably sustained perhaps one and a half million humans in a life chiefly supported by hunting and fishing with some isolated patches of elementary agrarian practice was suddenly called upon to sustain 185 million people at a standard of living superior to any in man's recorded history. The impact of this biological explosion upon the balance of Nature in North America defies description and is but incompletely annotated.

Whether this is good or bad depends, of course, on one's own personal viewpoint. To the Naturalists, the lovers of wildlife, of virgin forests, and of plains and mountains, it is regarded as catastrophic, although one suspects that they are none the less glad to be living along with us to partake of the particular advantages thereof.

The average American citizen is happy to be part of 20th century America, with its standard of living, its pleasures and its prospects, and he is glad to be able to raise his children in such munificence. In general, he would like to see the rest of the world as well off and as satisfied as he.

From the objective standpoint it cannot be regarded as all good or all bad; it must be assayed in balance, the good versus the bad. It must be seen that we cannot have it both ways at the same time. We cannot have an exploding population and at the same time have all the space and wildlands of former years.

We start with the premise that our first concern is the preservation of man himself. Our second premise is that man's standard of living is to be continually advanced. We propose to attain these objectives even at the expense of other forms of life, animal or plant, if such a choice has to be made. We define man's "preservation" as his longevity to a duration of as many years as it can be extended, for we will not willingly allow any man to perish unnecessarily, particularly by tragic means, if we can prevent his demise. We define "standard of living" as provision of the essentials of life—food, clothing and shelter—with the minimum expenditure of man's time, effort and facilities, thus allowing whatever surplus productive capacity he may have to be applied to advancing his welfare, his education, his security and his pleasure. We also, in America at least, adhere to the belief that the direction, scope and extent of these efforts should be a matter of personal decision and freedom of expression for each individual concerned, provided such expression does not at the same time curb the freedom of other men. To this end we write laws, establish courts, appoint judges, prepare a jurisprudence and hire police.

This, simply, is civilized man's objective in life, and such must of necessity frequently contest the rules of Nature, for as man increases his own numbers in geometrical progression he must inevitably come into deeper and more intense conflict with Nature.

The basic requirements of man are food and fiber. In the production, storage and distribution of these, he comes into direct competition with a vast array of fellow creatures. Some collaborate with man and are content to become his meat animals or his plant foods; others compete vigorously in myriad forms and ways to impede the production of his foods or to effect their consumption or decay. These contestants for his food and fiber man arrogantly calls pests; arrogantly for he is really just as much a pest to them as they are to him.

These pests are, in part, microscopic creatures such as bacteria, fungi, rickettsia, viruses, amoebae and flagellates and, in part, macroscopic creatures such as insects, arachnids, nematodes, worms, cestodes, reptiles, molluscs, many mammals and birds, and a wide array of non-edible plants.

Fortunately for man, the vast majority of these creatures do not seriously compete with man, not because they wish to avoid or please him but merely because their interests and tastes differ from man's and, consequently, they occupy areas of living space unfrequented by humans. Unfortunately, however, they are being increasingly encroached upon by man, often unintentionally. It is with this invasion of wildlife that the Naturalists are chiefly concerned, for they prize these innocent creatures because, although they may be of no trouble to man and often of little use, they may none the less find their natural habitats invaded by the incessant extension of man's living space. This is, of course, most regrettable, and man must arrange wildlife preserves for such creatures, as he has already done in many areas, particularly in North America.

In the struggle for survival man can only hope to maintain his advantage over the insect, by far his most formidable biological competitor, by a rigorous exercise of every gain he can muster, abeit at times at the expense of less competitive or even innocent species. Man *must* secure his needs of food and fiber, preferably with minimal harm and injury to other living creatures, but serve his needs he must or he will fail to survive. The choice is simple, stark and real. The only question of importance to man, therefore, in the use of chemicals in his contest with the insect, fungal, bacterial or nematodal worlds is the possible side effects such chemicals may have on his own welfare. Is the margin of safety to man—in both the short and long term—of each chemical sufficient to merit its use? This he must assess by assiduous research in each particular case.

Thus if man can eradicate malaria, or yellow fever, or typhus, or aster yellows, or Dutch elm disease, or wheat stem rust by complete destruction of the causal agent or related vector species, then this is his logical course of survival whether or not such drastic action upsets the balance of Nature. Man will miss neither the Anopheles nor the Aedes mosquito; he would be well rid of the screwworm, the cotton boll weevil, the Hessian fly, the corn ear worm, and corn borer and a host of other major competitors for his food and fiber supply. Certainly such eliminations will upset the balance of Nature and some creatures, entirely innocent, may have to seek other sources of food and areas of living space.

But this is life continually surging to and fro in furious contest, as it has since the first living creature came into being perhaps a billion or more years ago. Now man, to some extent and for a little while at least, can sway the contest to his favor to gain perhaps a further slight edge over his fellow creatures. How long man can extend and sustain his dominion over other life on the planet will depend upon many factors, including his own behavior and his growing numbers. But one point seems indisputable: he cannot long survive without fulfillment of his material needs, which demands the control of all competition for his food and fiber supply.

The necessary concentration of food production into areas of optimal facility for each type of foodstuff, and the coincident concentration of great masses of the human population in urban and suburban areas, necessarily disturb the balance of Nature in so many respects that it has become imperative for man to re-establish the balance of life according to his precise needs, designed to meet *his* requirements, not those of Nature. He therefore thrusts aside the natural checks and balances which formerly sufficed to restrain any single species of insect, fungus, bacteria or the like from exceeding its prescribed or allowable number and space.

When man decided to grow 100,000 acres of cotton plants in a stretch where but a few isolated patches once grew, or raise 50,000 apple trees in a few discrete blocks instead of a single tree among other species, or rear 40,000 chickens in a single house as compared to a dozen little chicks peeping enthusiastically around a motherly old hen back of the barn, and as the modern specialized farmer at once concentrated and expanded his specialty, then Nature's system of balances became both ineffectual and obsolete, and a new and revised approach to disease and insect control became essential.

Prevention became paramount; prophylaxis based on anticipation of disease took precedence over the delayed reaction of therapy or cure. It was soon realized that awaiting the appearance of a disease or pest in the massed flock or herd or planting before control measures were applied resulted in severe losses. The vast array of compact susceptible hosts encouraged a parasitic invasion of epidemic proportions, and sifting out the affected individuals for treatment became a practical impossibility. The solution, therefore, lay in prevention, in a built-in control, in complete prophylaxis. Such a requirement called for all measures which could hold the parasite away from its host and/or pretreatments which could keep the prospective host in a state of continuous immunity or resistance. This can be accomplished in a variety of ways—by vaccination, breeding, sanitation, chemical treatment and nutrition—depending upon the host plant or animal, the pest involved and the economics of the control related to the value of the product.

In general, chemical methods of control are the cheapest, most effective and most reliable. There are some biological techniques which are effective, notably vaccines to prevent viral disease in domestic animals, but biological predators are generally too slow, too specific, too expensive, too incomplete and too unsatisfactory, although admittedly there are exceptions. One thing is certain: complete reliance upon biological control of insects by predators, as requested by Miss Carson, would undoubtedly increase the cost of all foods to a point where many products now available at low prices at all seasons of the year would become completely unobtainable, while others would appear in the market for short periods each year and be of exceedingly poor grade at exorbitantly high price.

Miss Carson completely ignores this central point in her book. The idyllic picture she paints is illusory, and she as a biologist must know that the rural Utopia she describes was rudely punctuated by a longevity among the residents of perhaps 35 years, by an infant mortality of upwards of 20 children dead by the age of five of every 100 born, by mothers dead in their twenties from childbed fever and tuberculosis, by frequent famines crushing the isolated people through long, dark, frozen winters following the failure of a basic crop the previous summer, by vermin and filth infesting their homes, their stored food and even their very persons, both inside and out.

Surely she cannot be so naive as to contemplate turning our clocks back to the years when man was immersed in Nature's balance and barely holding his own. Indeed in many areas of the world, including some colonies in America, he failed to withstand the competition and ignominiously expired.

Today man can maintain himself anywhere on earth. Within 100 years man has emerged from a feeble creature, virtually at the mercy of Nature and his environment, to become the only being which can penetrate every corner of the planet, communicate instantly to anywhere on earth, produce all the food, fiber and shelter he needs, wherever he may need it, change the topography of his lands, control the primary energies of the land, the seas, the heavens and the universe, and now prepare his voyage through the arch of heaven out into space itself.

This is the stuff that science is made of, and man has learned to use it. He cannot now go back; he has crossed his Rubicon and must advance into the future armed with his reason and the tools of science, and in so doing will doubtless have to contest the very laws and powers of Nature herself. He has done this already by expanding his numbers far beyond her tolerance, and by interrupting her laws of inheritance and survival. Now he must go all the way, for he cannot but partially contest Nature. He has chosen to lead the way: he must take the responsibility upon himself.

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THE ROLE OF AGRICULTURAL CHEMICALS IN FEEDING AN EXPLODING POPULATION*

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The Reverend Thomas R. Malthus in his brilliant Encyclopedia Britannica article "A Summary View of the Principle of Population" stated in 1824:

"... that population, when unchecked, increases in a geometrical progression of such a nature as to double itself every twenty-five years" ... "But by the laws of nature ... the food which it produces ... must increase the means of subsistence only in an arithmetical progression."

In spite of the derision and disrepute into which the Malthusian Theory has fallen over the intervening years, Malthus was absolutely correct. The population of the world has increased geometrically, and in spite of wars, famine and disease has done so with surprisingly little deviation for about the last 7000 years.

"DOOMSDAY" PREDICTED

Recently Foerster, Mora and Amiot writing in *Science* (Vol. 132 No. 3436: 1291: 11.4.60) computed the course of world population from 5000 BC till today and calculated "doomsday" as 13 November AD 2026. "Doomsday" is defined as the day when the population of the world arrives at 50 billion, or at 10,000 people per square mile of land surface. The present population of Japan (and the State of New Jersey) approximates 800 people per square mile.

Obviously any conceivable expansion of our food production will not be able to meet the minimal nutritional needs of a population approaching even 25 billion.

For today, with a world population approaching three billion, approximately four out of every five people die directly or indirectly from the effects of starvation. Between three- and four-fifths of the people now have an average daily gross intake of not more than 1800 calories per day, which is excessively aggravated by serious nutritional imbalances of both protein and vitamins. The World Health Organization of the United Nations reports that upwards of 50 per cent of the world's people ingest less than 1500 calories a day—a status of direct starvation.

The minimal arable acreage requirement to sustain one human in food (2200 calories/diem) and fiber was established in 1945 as 2.5 acres. In

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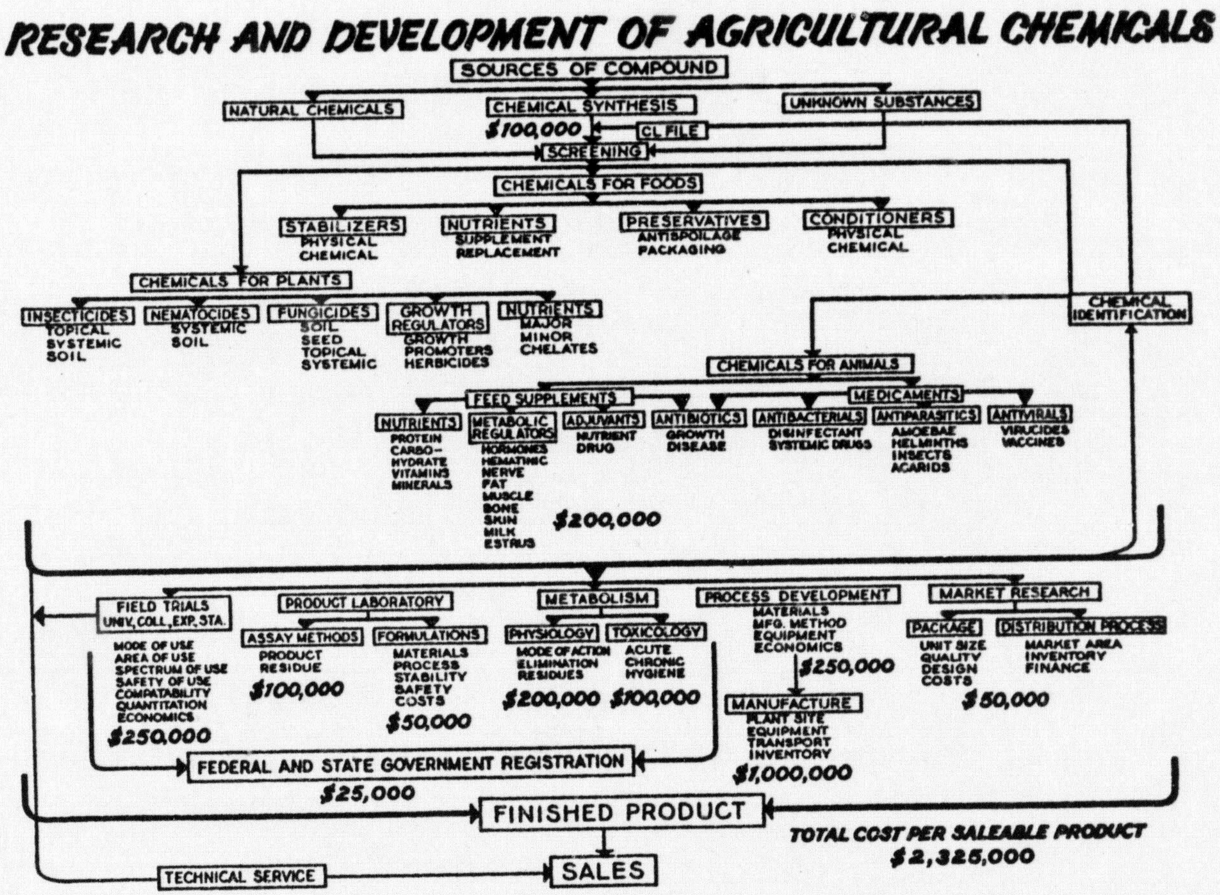
RESEARCH AND DEVELOPMENT OF AGRICULTURAL CHEMICALS
SOURCES OF COMPOUND
NATURAL CHEMICALS
CHEMICAL SYNTHESIS
UNKNOWN SUBSTANCES
$100,000
CL FILE
SCREENING
CHEMICALS FOR FOODS
STABILIZERS
PHYSICAL
CHEMICAL
NUTRIENTS
SUPPLEMENT
REPLACEMENT
PRESERVATIVES
ANTISPOILAGE
PACKAGING
CONDITIONERS
PHYSICAL
CHEMICAL
CHEMICALS FOR PLANTS
INSECTICIDES
TOPICAL
SYSTEMIC
SOIL
NEMATOCIDES
SYSTEMIC
SOIL
FUNGICIDES
SOIL
SEED
TOPICAL
SYSTEMIC
GROWTH REGULATORS
GROWTH
PROMOTERS
HERBICIDES
NUTRIENTS
MAJOR
MINOR
CHELATES
CHEMICAL IDENTIFICATION
CHEMICALS FOR ANIMALS
FEED SUPPLEMENTS
MEDICAMENTS
NUTRIENTS
PROTEIN
CARBO-HYDRATE
VITAMINS
MINERALS
METABOLIC REGULATORS
HORMONES
HEMATINIC
NERVE
FAT
MUSCLE
BONE
SKIN
MILK
ESTRUS
ADJUVANTS
NUTRIENT
DRUG
ANTIBIOTICS
GROWTH
DISEASE
ANTIBACTERIALS
DISINFECTANT
SYSTEMIC DRUGS
ANTIPARASITICS
AMOEBAE
HELMINTHS
INSECTS
ACARIDS
ANTIVIRALS
VIRUCIDES
VACCINES
$200,000
FIELD TRIALS UNIV., COLL., EXP. STA.
MODE OF USE
AREA OF USE
SPECTRUM OF USE
SAFETY OF USE
COMPATABILITY
QUANTITATION
ECONOMICS
$250,000
PRODUCT LABORATORY
ASSAY METHODS
PRODUCT
RESIDUE
$100,000
FORMULATIONS
MATERIALS
PROCESS
STABILITY
SAFETY
COSTS
$50,000
METABOLISM
PHYSIOLOGY
MODE OF ACTION
ELIMINATION
RESIDUES
$200,000
TOXICOLOGY
ACUTE
CHRONIC
HYGIENE
$100,000
PROCESS DEVELOPMENT
MATERIALS
MFG. METHOD
EQUIPMENT
ECONOMICS
$250,000
MANUFACTURE
PLANT SITE
EQUIPMENT
TRANSPORT
INVENTORY
$1,000,000
MARKET RESEARCH
PACKAGE
UNIT SIZE
QUALITY
DESIGN
COSTS
DISTRIBUTION PROCESS
MARKET AREA
INVENTORY
FINANCE
$50,000
FEDERAL AND STATE GOVERNMENT REGISTRATION
$25,000
FINISHED PRODUCT
TOTAL COST PER SALEABLE PRODUCT
$2,325,000
TECHNICAL SERVICE
SALES

FIG. 1

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the United States in 1955 there were 2.80 acres of arable land per person (population 164 million); in the world as a whole there were 1.25 acres per person, with considerably less in the populous countries of Asia. This allowed surplus food production in the United States, where indeed overeating became a problem, but in the rest of the world great areas have been at or near starvation.

By the year 2000 the population of the U.S. will approach 400 millions and the arable land, including anticipated reclaimed lands, will be 1.46 acres per person; in the world as a whole, however, there will be less than half an acre of tillable land per person.

"AN EMPTY BELLY . . ."

It is obvious that this presages catastrophe for our type of civilization, unless food and fiber production can advance at a greatly accelerated rate. The political-economic impact of this struggle for the bare necessaries of life has been gaining increasing momentum over the past half-century, and the international unrest and tensions of the present are a reflection of the strain between availability and need for food. The tension will inexorably increase, for when men approach hunger they have nothing to lose, and gain can be the only reward of survival. A Russian proverb says, "An empty belly knows no law."

M. C. Chagla, Indian Ambassador to the U. S., stated:

"I want you Americans in your land of plenty to imagine what it means for tens of millions of children to be born who will suffer from malnutrition, who will have no homes to live in, who will have no employment when they grow up, if they grow up, and who will spend their entire lives as disgruntled, envious and embittered human beings—a ready prey to any idea, no matter how monstrous, which might promise them surcease from their squalor and escape from misery, a hope for better prospects and a life more tolerable to live."

WHERE COMMUNISM GERMINATES

Mr. Chagla has described the fertile ground in which the seeds of communism and anarchy can germinate and flourish and has remarked the basic cause of political unrest among the seething masses of southern Asia. Similar conditions are developing rapidly all over the world, and touching our own continent in Central and South America today.

Even in America our population is increasing at a rate calculated to remove our politically embarrassing food surpluses in but a relatively few years. To feed this population in the United States we shall require by the year 2000 an additional 400 million acres of arable land, assuming we can maintain our present yields and productive efficiency. As we do not have

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such arable acreage available, we must turn elsewhere to meet this inevitable demand. Alternatives include extending our hegemony over foreign and probably already overcrowded lands, a course repulsive to our very national ethics, or embarking on an intensive population control plan, a matter of great political and spiritual controversey (but none the less inevitable), or we can turn to science and research and expand our food and fiber production far beyond the furthest reaches of our present horizons. We are, in fact, doing this now, for our food production is increasing as rapidly as our population, at least for the present.

In this land of apparently interminable surpluses, we have become not only physically surfeited but complacently apathetic about our food supply. The relatively small cost of our surplus is today a major political issue, yet it is really a minor expense for the insurance it bestows upon the income of the farmer and the cost of food to the consumer. A five per cent food surplus costs the nation only a fraction of what a similar deficit would cost the housewife in increased food prices.

The biblical Joseph stored a surplus of grain in ancient Egypt for the seven lean years, and has been accorded the wisdom of the ages for so doing. Today our surplus would hardly carry us for seven lean months, and if used to feed the hungry peoples around the world, it would be exhausted in less than two months. Thus even with our proficient agriculture and our surplus abundance we are, in fact, not more than a year or two away, at the very most, from starvation right here in America. This, then, is the frame of reference within which any major factor affecting agriculture must be viewed.

"FOOD EXPLOSION" NEEDED

So apart from a general world population control—a "peoplo-stat"—the only factor which can possibly relieve the increasing international stress is a "food production explosion" to match that of the world population. Although it is obvious that some form of population control is inevitable, a world "food production explosion" is now quite feasible.

Indeed, such has already taken place in the United States during the past 50 years and it can continue with accelerated tempo. If political, social and particularly religious mores can be swiftly swept aside, an equally effective "food explosion" can be accomplished around the world within the next half-century, to the immense relief of most of the international tensions which disturb mankind today.

The Foreign Research Service of the U.S.D.A. has recently computed that the total deficiency of food in the world today aggregates 46 million metric tons of protein-calorie equivalent, which represents 35 per cent of current U. S. milk production plus 45 per cent of bean and pea production

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and plus 120 per cent of U. S. wheat production per annum. Vast as this deficiency is, it is within reach of increased production in North America alone, and could easily be attained in the world as a whole.

"KNOW-HOW" AVAILABLE

There is now on hand the requisite technology, know-how, equipment, supplies, facilities and capital to increase the world production of grains, pulse, meats, vegetables, fruits, dairy products and fish by a factor of ten within the next decade. It has taken the United States and the other Western nations 150 years to resolve the myriad natural problems which had held farming in chains for five millenia; but now these difficulties have yielded to the advance of science and the fantastic productivity of the American farm is the proof of our success. For we have truly made four blades of grass, four ears of corn, four hogs and four fruits to grow where (as one frustrated Congressman on the Agricultural Committee said), "Damn it! only one ought to grow." We have done this and we could, with effort, make it eight or even sixteen.

This has come about through research and the rapid and assiduous application of its findings literally to the grass roots out on the farm. Our land grant college system, now celebrating its centennial, has taught our rural peoples how to farm scientifically and has, more importantly, inculcated a thirsty curiosity among them to learn and to put into practice every original idea, new piece of equipment, improved strain of animal or plant, useful chemical, redesigned soil management program and fresh approach to the market which their research has produced in a continuous flow over the past century.

We have drawn upon the basic researches of many fundamental and pragmatic sciences in the solution of problems in the production of our food and fiber. The hundreds of thousands of published and recorded journal papers, station bulletins, reviews and texts stand witness to the stupendous intellectual and physical effort which has been devoted to increasing the productivity of American agriculture.

ASTOUNDING BREAKTHROUGHS

We have done this because we have used the scientific method under freedom of thought and enterprise. We have made astounding breakthroughs in plant and animal breeding, in soil management, in forest engineering, in pest control, in agricultural machinery, in animal nutrition and disease control, in food processing and distribution. Each factor has been linked into a continuous chain extending from scientific imagination to the farmer tilling the soil. The research scientist, the technical agriculturist, the industrial chemist, the biologist, the college professor, the county agent and the farmer have, hand in hand, advanced relentlessly over the past century and subdued, one by one, the most baffling problems and scourges that have beset and plagued mankind since the dawn of history. It has been the work of many people and each has been as important and significant as the other. Great names in agricultural science have come and gone and are revered among us, but no one can assume credit for more than a minute fraction of this great achievement. It has been perhaps the most resounding victory democracy has won.

This is a victory we cannot and must not allow to slip away. It is our margin of security in the modern world. Yet this is precisely what can happen if certain forces currently abroad are allowed to range unchecked and unchallenged. I refer to recent developments in the pesticide and Food Additive Laws, to the administrative interpretation of these laws, and particularly to the wild and fearful publicity which has been made of these laws and their relationship to the use of agricultural chemicals and feed additives on the farm and to the health of our people.

THE "DELANEY CLAUSE"

No one questions the validity and necessity of Federal and State laws designed and administered to protect the health of the consumer of farm products; and every responsible worker in agricultural research, extension and industry recognizes the necessity to establish the safety, as well as the efficacy, of every new chemical to be used in or on edible crops and foodstuffs, *before* such a compound is released for general use. The recent amendment which centered the responsibility for such prior proof of safety upon the manufacturer is just and certainly acceptable to industry. However, attached to the amendment at the last moment was a clause, known as the "Delaney Clause," which, in a few words, if administered literally would reduce the whole agricultural chemical industry and, more important, its function on the farm to a veritable shambles. This circumstance can stop the rapid advances of agricultural science completely, for it will discourage the chemical industry from searching further for new compounds with which to combat the unresolved scourges of the farmer, and it will inevitably leave the grower at the mercy of a thousand pests which will boil back with both relish and alacrity once the pressure of control is removed. The impact of this will be, of course, not only a rapid decline in the volume and variety of the bright array of foodstuffs to which we have so happily become accustomed, but more significantly it will result in a sharp rise in its price—by perhaps a factor of as much as tenfold.

LACK OF DEFINITION

The Delaney Clause states that no residue tolerance is allowable on any chemical used in or on a food or feed product if it is "found to induce cancer when ingested by man or animal." On the face of it this sounds reasonable enough, and certainly no responsible scientist, industrialist, food processor or farmer advocates the increase in cancer under any circumstances. The problem arises from the blanket coverage and lack of definition in the Delaney Clause. No indication is given as to how a compound is to be identified as a carcinogen—or cancer inducer—and this is a very debatable point even among cancer specialists. No indication is made as to what dosage level can be allowed or how the resulting residue tolerance can be determined, and as a zero residue is obviously an impossible value to measure, a suspect compound cannot legally be used at all, even under a zero residue registration. For, as analytical procedures are refined, what is a zero residue today may be a detectable or even appreciable level tomorrow. Finally the Delaney Clause implies the compound must be proven to be non-cancer inducing in humans as well as in animals. This is a manifest impossibility to achieve even if such experimentation was feasible, for one may be able to prove a compound *is* a carcinogen, but one cannot prove it is not, anymore than one can prove one is not married. By strict interpretation then, the Delaney Clause virtually precludes all new compounds from the agricultural and food market.

SUPERSTITION GAINS ASCENDENCY

As with all such matters of general concern and vast complexity, ample opportunity is provided for misunderstanding, illogical conclusion and unfounded fear to arise. In such an atmosphere, decisions of policy affecting the welfare and livelihood of millions of people may be based not on knowledge but on a lack of it, and prejudice and superstition gain ascendency over scientific truth. In recent months, while hesitancy reigned in administrative quarters, a noisome and prevaricative publicity has been made of these new laws, of their relationship to the use of agricultural chemicals in the production, processing and distribution of our foodstuffs and of the alleged hazards these substances may have upon the health of the people. A wave of fear and alarm has been deliberately fomented among the consumers of our country, a wave calculated to sweep away the trust, assurance and honest thinking in the business of agriculture and food production that it has taken our agricultural colleges, experiment stations and industry nearly one hundred years, and uncounted effort, to establish.

This critism, essentially destructive in tenor and intent, is based on half truths, scraps of irrelevant and unrelated evidence, much of it taken out of context and out of time, and largely founded upon superstition and outright falsehood. Books have been published under sensational and misleading titles by authors with neither training nor experience in the fields they purport to discuss; articles have appeared in obscure journals whose goal has been circulation rather than veracity; and the net effect has been to incite fear and consternation among the consumers of America out of all proportion to any possible or real danger involved.

A.M.A. POSITION

The Council on Foods and Nutrition of the American Medical Association has recently (*J.A.M.A.* Vol. 178 No. 7: 11.18.61) published the following official statement:

"The Council on Foods and Nutrition recognizes the contributions that chemical substances in food production, processing, and preservation have made to the quality and quantity of the American food supply. While many chemical additives are essential to efficient agricultural production, others are vital to the manufacture of food products. There is no reason to believe that the present use of chemicals in foods is endangering the health of people. Responsible manufacturers have made careful safety tests before the introduction of new chemicals, and the Food and Drug Administration is diligently and effectively protecting consumers from presence of hazardous chemicals under existing federal laws.

"It is the considered opinion of members of the Council on Foods and Nutrition that the Delaney Clause . . . and the similar clause . . . in the Color Additive Amendments . . . prohibiting the setting of tolerances for the use of carcinogens in foods should be either repealed or revised. Technically, this special provision contributes nothing to the safe use of food additives since any hazardous use of an additive is already prohibited in the general provisions of the food additive amendment. It is probable that the clause could prohibit the addition of certain essential nutrients to foods if a substance was shown to be carcinogenic in any amount. A literal and overly broad interpretation of the Delaney Clause would not make a demonstrable contribution to public safety."

Many statements have appeared recently in the popular press which are deliberately calculated to generate electoral support for those who propose legislation that only hampers the progress of our agriculture and with it the highest standards of living, health and happiness that man has ever known. The only alternative offered for our present process of agriculture by these critics is to return to the jungle and employ the so-called natural or "organic" way of life. It never occurs to them, apparently, that this is precisely the way some three-quarters of the people of this earth do live now—if it can be called living. There are hundreds of millions of wretched, crawling human beings desperately clawing their way from one scrap of food to the next, with neither thought nor desire for the science of farming to improve their lot. This is to what the natural, "organic" way of life has chained them. It could very readily also reduce us to the same bondage if we should abandon the scientific process in our agriculture. One point is clearly certain: nature would quickly re-establish her balance, and the first factor to be balanced off would be man himself (he would promptly be decimated), for in terms of the biological law of equilibrium man himself has become a veritable plague upon the face of the earth.

"WILD . . . THEORIES"

One so-called "authority" on the "organic way" recently stated in a published book that the development of cancer late in life is induced long before or during the mother's pregnancy, and even earlier perhaps, by her inconsiderate ingestion of foodstuffs treated with additives or fruits and vegetables sprayed with pesticides. From this point he extrapolates his thesis to include the diet of the father also as having a delayed carcinogenic response in the offspring. Surprisingly, the "eminent doctor" failed to seize the opportunity to contend that the most effective anticarcinogen, therefore, would be contraception.

Amusing as some of these wild, and obviously untested, theories of farming are, unfortunately it has now become a very serious matter. The immense strides taken by agricultural science in America have effected a highly significant political shift in the interests and livelihood of the electorate. One hundred years ago one farmer fed himself and three others; today he feeds himself and twenty-four others. These surplus non-agricultural peoples are those who have made our industries, our education, our research and our culture flourish. This has given America its power, but it has also inflated our cities and suburbs and proportionately reduced our rural peoples concerned with farming. The result is that the American farmer is rapidly becoming a political minority by dint of his own industry and competence. At the same time, forces are appearing in our Federal and State legislative bodies which, pressured by uninformed but vociferous groups, are introducing legislation that can contribute virtually nothing to the welfare of our people as a whole and concomitantly severely harass our farmers and impede the progress of our agriculture.

OTHER BILLS ENACTED

The Delaney Clause, discussed above, is a case in point. The Sherman Cooper Bill relating to the use of animals in research is another. There have been similar bills considered and passed by State legislatures, and generally hastily rescinded in confusion. One required a farmer or feed dealer to secure a veterinarian's prescription each time he supplemented a batch of mixed feed with a sulfonamide drug; another required that each crate or box of packed vegetables or fruit would have an adhering sticker that listed all the agricultural chemicals (by generic name) employed in the raising of

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the crop. As any box of produce from a packing shed could readily represent as many farms as the number of units in the box, the costly impracticality and utter infeasibility of such proposals should be obvious. The mere fact that such are not obvious illustrates vividly the colossal ignorance of practical agriculture that obtains in such legislative quarters.

The one point emphasized by Dr. Emil Mrak, Chairman of the California Special Committee on Public Policy Regarding Agricultural Chemicals, was that throughout the hearings, among urban consumer groups, there was a consistent sense of ignorance and suspicion concerning agricultural chemicals and a consequent distrust of the farmer, the extension man, the college and industrial research worker and of the Federal and State control administrators. This, of course, is revealed repeatedly in the various books, pamphlets, magazine and newspaper articles published on the subject for public consumption. This is the real problem confronting us, and one to which all of us concerned with agriculture should address ourselves with tenacity and vigor. For in a democracy it is essential to let the people know the facts and, having done so, we can rely upon their collective judgment.

There are few people who have a clear concept of the investment in expense, time, effort and facilities by both government and industry involved in the discovery, development and commercial application of a new agricultural chemical.

"ARRANT NONSENSE"

Too many of the general public, including some members of State and Federal legislative bodies, have accepted without question some of the arrant nonsense published in the lay and pseudoscientific press, which implies that new chemicals are dumped into commercial channels without adequate testing for safety, efficacy and economic validity. The immense investment required to meet the established regulations of both Federal and State offices, which currently averages over two million dollars per new compound, is assurance enough that no company is going to be cavalier about the utility or the safety of their product in the market place.

There is a distinct difference between the approach of a college or experiment station and that of a commercial company into the field of agricultural chemistry. The land grant colleges and experiment stations have a specific locale of responsibility within a state, for perhaps a single crop or group of related crops or domestic animals. Their concern is one of specific problems. They look for a method to control the problem, turning to convenient sources available to find the solution. Their approach is, in short, local, specific and intensive.

THE SCREENING PROCESS

The chemical company, on the other hand, searches for new chemicals and more economic sources of familiar compounds. It screens these chemicals in search of useful activity, and the nature and direction of the screens employed depend upon the market interest and facility of the company in question. If its interests are confined solely to pesticides, it may restrict its screening procedures solely to these objectives. On the other hand, if the company has wide and varied interests, it may retain a central file of all its chemicals and systematically screen them over a wide array of quite unrelated uses.

Each screening test is a carefully researched and statistically calibrated procedure designed to sort out active from inactive candidates with a precision of at least 95 per cent. Any candidate which emerges positive in the primary screen is at once checked in secondary and tertiary screens to confirm its activity and raise the odds for acceptance from 95 per cent to over 99.9 percent. Once a particular activity is established, all its chemical relatives (analogues) are also screened to determine if even more useful related compounds can be found.

Once a positive possible utility among a family of compounds is established, search is then made to determine in what areas of the country and on what product, crop or animal it is likely to be of valid economic use.

Approach is then made to the agricultural college and experiment station staffs who are expert in the particular problem to which the compound appears to be applicable. On the basis of the preliminary utility and safety data, they will decide whether to go to the field with the compound and apply it experimentally under proximate farm conditions. Such field testing usually proceeds simultaneously in as many as a dozen or more areas and over a period of at least two years and often for as long as five years.

Concomitant with these extensive field trials, the company proceeds with research and development of other phases necessary to establish safety, stability, compatability, metabolism, toxicology, formulations, manufacturing process development, and finally market research to determine where, how, when, and in what form to introduce the product into commercial channels.

TWO YEARS IN DEVELOPMENT

After at least two years, and usually more, of this intensive research and development, the entire data sheets are collated into a comprehensive report and submitted to the regulatory offices of the Federal government that are concerned, usually the U.S.D.A. and the F.D.A. Their experts go over the evidence in detail, usually requiring additional evidence of

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safety, utility, control, etc., or further elaboration of that data already submitted. Then, if the government examiners are satisfied that the compound fulfills the legally established requirements in accordance with proposed label claims; that the host plant or animal is adequately tolerant to it; that it is safe for humans to use or consume; that it is practicable to use; that it is stable in storage and distribution in the time and environment of its use; that it is compatible with other materials likely to be used with it; that it can be assayed reliably in its method of use; and finally, that the product is economically valid—then it may be registered.

Only when this roster of regulations is met to the full satisfaction of the government authorities is the product registered and allowed to enter interstate commerce, and then only within the strict confines of its approved label claims and recommendations and within those states whose own regulatory agencies are willing to accept the data as presented to the Federal authorities.

DANGER REDUCED TO MINIMUM

This long and tortuous course is by no means complete, however, when the first label is registered, as it must be, at least in part, repeated for each successive additional use and label claim for which registration is sought. It is obvious that this necessary and accepted restraint upon the evolution of new chemicals for agriculture exerts a massive screening effect that reduces the chances of the emergence of products, dangerous to the consumer, to a minimum.

The fact is that new chemicals are so critically studied and examined before they are released for commercial use that their potential hazards to human health are not only less but better understood than many of those which occur in so-called "natural" foods.

CARCINOGENS IN "NATURAL" FOODS

One of the major themes constantly recurring in the literature opposed to agricultural chemicals contends that only "natural" compounds are safe and only "natural" controls of pests and diseases are really effective. The argument that only "naturally grown food-stuffs" (whatever that means) are safe for human consumption because nature ensures that they will be free from carcinogens, toxins, allergins, goitrogens, adverse enzymes, etc., is completely in error.

There are, in fact, a whole array of well-accepted and long-used "natural" foods which are now known to contain appreciable amounts of suspect carcinogens, and doubtless many more will become known as food chemistry advances. A few familiar examples are tannic acid in tea, in nuts and in many fruits; capsicum in peppers; thio-urea derivatives in

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virtually all cole crops; arsenic in shell fish; selenium in many cereals, fruits and vegetables (which incidentally is quite possibly an essential nutrient element for all warm-blooded animals, including man); cobalt in all meats (also a major component of vitamin B_{12} essential for blood formation); iron found in virtually all foods (and a component of human blood); estrogens found in all meats and also in humans.

Whether such substances induce carcinomas or not depends, of course, upon a number of other factors, the principal one of which is dosage intake versus metabolism and elimination rate. Similar consideration applies to all agricultural chemicals.

It is frequently argued that pesticide and feed supplement residues are objectionable even in minute amounts as they may induce allergies, yet innumerable natural foods induce allergy in man. Such common foodstuffs as cow's milk, eggs, fish, particularly shell fish, pork, chicken, cheeses, wheat, corn and a wide variety of fruits and vegetables are authentically recorded as allergenic in man under certain conditions, regardless of whether they have been treated with agricultural chemicals or not.

There is also a wide variety of cyanogenetic (cyanide producing) compounds found in the seeds of almond, peach, plum, apricot, cherry, apple and pear; also in lima beans and java beans and, of course, in the Christmas treat marzipan; and in many animal fodders such as sorghum and grasses (Johnson, Sudan, Bermuda and arrow), in white clover and linseed cake.

Again there are natural foods which contain anti-enzymes that can readily induce vitamin deficiencies when consumed in excess. Examples include avidin from raw egg white, which produces biotin deficiency, thiaminase in certain fish produces vitamin B_1 deficiency (beriberi); pellagrogen in corn meal induced a widespread condition of pellagra among the poorer peoples of the Southern states until it was recognized as a niacin deficiency.

Among animals dicumarol in certain clover hays induces vitamin K deficiency and hemorrhage, while unsaturated fats in the diet of poultry may induce encephalomalacia which is controllable with dietary vitamin E. Linseed oil meal fed in excess can induce a vitamin B_6 (pyridoxine) deficiency.

THE "CRANBERRY BOGGLE"

During the "cranberry boggle" of 1959, the industry was virtually ruined because it was alleged that part of the crop had been "sprayed with a violent carcinogen." Actually the experimental evidence accumulated both before and since the incident indicates that the accused compound is not a carcinogen but a goitrogen, a chemical which will cause the thyroid gland to enlarge, presumably by preventing the gland from absorbing sufficient iodine. The effect has been found to be completely reversible by removing the compound from the diet, a fact, incidentally, which should be sufficient to also remove it from the carcinogen list. Furthermore, the maximum amount of residue found on the cranberries, a small number of which had admittedly been illegally sprayed (in violation of label instructions, incidentally), was of such magnitude as to require the daily consumption of some 15,000 pounds of raw cranberries for over ten years to provide a goitrogenic dose in man. This would have been a prodigious gastronomic feat even for Paul Bunyan.

However, a much simpler way to secure appreciable levels of goitrogen, if so inclined, is to turn to "natural" sources with a diet well fortified with turnips, kale, cauliflower, peanuts, soybeans, mustard, beets, peas, beans, spinach, lettuce, carrots, celery, chard, green peppers, filberts, pears, strawberries, peaches, apricots, raisins, milk, oysters, clams and, that epitome of all natural food lovers, raw liver. The list looks like a recipe from a book on "organic gardening," but be sure not to cook any of the items: it destroys the active principal.

CONTROL OF INSECTS

Biological control of insects, parasites and diseases is admittedly the ideal method of control; however, it is highly specific, too late, too slow, too uncertain and too costly. Nevertheless in certain specific areas it has been significantly successful. The milky disease control of Japanese beetle, the irradiation sterilizing of male screw worm flies, the use of lady beetle (coccinella) larvae to control alfalfa aphids in the valley pockets of the Western mountains, and spraying or dusting the spores of *Bacillus thuringiensis* for control of certain moth and butterfly larvae are all good examples of effective biological control. However, each is quite limited in the scope of its use and efficacy.

The grower, however, is confronted with a whole array of pests, insects and acarids, fungal and bacterial diseases, parasites and weeds, several species of which may attack his crop or animal herd simultaneously or sequentially during its production life. Control of one pest and none of the others, or even control of all but one, is often as futile as controlling none.

Federal and State authorities require the farmers' products to be free from insect blemish and disease, to be of specified grade size and conformity for interstate shipment his animals must be free from contagious disease, vermin and parasites to pass meat inspection department standards. He therefore cannot, indeed he must not, fall below the rigid requirements of grade and quality. Furthermore, the processor who packs the grower's raw product is obliged to meet label specifications rigidly if he proposes to ship in interstate commerce.

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"ORGANIC FARMING" IN CHINA

The grower must, therefore, exercise precise and exact control over *all* the pests that plague his crops all the time. How he can be expected to do this without agricultural chemicals is, of course, a point the "organic school" answers by maintaining that if the grower only used organic manures (no "hideous" chemical fertilizers), if he allowed the birds to eat the few, very few, insects that would deign to attack "organically grown" crops, if he would throw away his pesticides and behemoth monstrous spray rigs, if he would just go back to "nature" and become "organic," he would have no troubles with his crops at all. This is, in fact, quite true of course, but only for the reason that he would have no crops at all—e.g., China, which has tried to grow crops "organically" for five thousand years and lives on the edge of starvation to this very day.

The farmer is therefore caught between the rigid rules of product grade, quality and uniformity laid down by the marketing administrations, Federal and State, on the one hand, and increasingly stringent limitations on the use of agricultural chemicals on the other, with no sensible, constructive alternative offered to relieve the encircling pressures.

There have been a number of reviews of the problem by competent committees and authorities, both Federal and State, in recent months. All have carefully considered the pros and cons of the relative value of the use of agricultural chemicals versus the alleged dangers to public health and wildlife conservation, and without exception these qualified groups have reported that food production and the nutritional living standards of Americans could not obtain if agricultural chemicals were abolished. Each group recognizes the potential hazards involved in the widespread use of certain pesticides but concedes the standard procedures worked out by Federal and State authorities in collaboration with industry are adequate and safe when such pesticides are employed in strict accord with approved label recommendations.

THE REAL PROBLEM

Unfortunately, most of these excellent reports are read mainly by technical agriculturists who are virtually in complete unanimity with one another as to the controlled and necessary use of agricultural chemicals. The real problem lies in bringing a sense of proportion and understanding to the general public on the necessary use of agricultural chemicals in the production of foodstuffs; in re-establishing public trust and confidence in the reliability and sincerity of agricultural research workers and administrative officials in the government departments, colleges, experiment stations and industry; and in convincing the consumer that the bright array of foodstuffs offered in the retail markets of America today is the most nutritious, wholesome, safe and economic (21¢ of the take-home dollar) of any country in the world.

This message must be hammered home in a thousand ways in a thousand places, and be given simply and factually in understandable terms and with sincere conviction.

For we do not have much time to prevaricate and to dissemble with our food supply; we have guests coming to dinner on New Year's Day 2000, nearly 400 million of them.

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THE CONTRIBUTION OF THE FARMER TO THE ENVIRONMENT

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INDIANA FARM BUREAU FEDERATION

Annual Meeting, Indianapolis, Indiana

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INTRODUCTION

The American farmer has committed the one unforgiveable sin in a democracy. By dint of his own proficiency and efficiency he has reduced himself to a minority, a fatal step in a democratic society. Added to which his inherent sense of self-responsibility, pride in personal independence and a rugged individualism have distinctly impeded if not virtually precluded his joining with his fellow farmers in legal union or group cartel to sustain at least his group independence if not his personal freedom.

The result has been the steady erosion over the past quarter century of his influence in both Congressional and State Legislative forums. Many states that were predominantly agricultural and rural in their economic and political complexion have now become urban states where over 65% of the population lives and works in cities or peripheral suburbs and whose political and socio-economic interests relate to urban and suburban affairs where agricultural and rural matters are so remote they are neither understood nor is there any longer a desire that they should be.

To such people the husbandman of food and fibre crops and livestock is a distant, essentially incompetent soul, who has been washed up on to the shore and passed over by progress and who is now somehow sustained by the Federal Government in an obscure form of rural welfare known as parity support. When he is considered at all by the urbanite the modern farmer is regarded as a very clever fellow who overcharges for the foods he produces which are both of

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poor flavor and contaminated with countless chemical residues all of which shorten life, induce cancer, mutations and monster offspring and which comprise the basic causes of all the ills of mankind.

Incredibly preposterous assertions are made daily in the urban and suburban press, radio and TV that it is the farmer who is primarily responsible for most pollution whether it is of the air, of the land, or of the waters beneath. It is claimed, often by those whose training and background really must assure them to the contrary, that the farmer pollutes the air with pesticides which travel to the ends of the earth, magnifying concentration as they spread, that he deteriorates the land by erosion, with fertilizers - inorganic and animal -, and with pesticides, that he contaminates the flowing waters sending toxins coursing downstream to be incorporated into municipal supplies. And so, it is claimed, he seriously denigrates and desecrates the environment because he obstinately and irresolutely refuses to obey natural law and farm his land under the so-called "Balance of Nature."

Were farmers, it is said, but to return like prodigal sons to the operation of their lands only by natural means, use no fertilizers but organic manures and crop detritus (which would, of course, require a considerable livestock investment to provide), apply no pesticides but to rely solely upon resistant varieties, management practice and biological controls of all pests through predators, parasites and diseases, then would our land return to those utopian days of the past, and wealth, abundance and a pristine environment would once again descend upon all of us, both rural and urban citizen alike.

This absurdity has now become a national hallucination, and although obviously a fad, which, hopefully, like all fads, will fade ignominiously into obscurity, appears currently to have exerted such a grip upon the urban majority that its impact is reaching into the very halls of Congress and various state legislatures and is becoming gelled in an array of laws, regulations and pronouncements, many of which are not only ridiculous but are actually impossible either to obey or to administer.

Delaney Clause Impairs the Environment

Thus, for example, the odious Delaney Clause of the Food and Drug Amendment has, in effect, made all food that traverses state lines in North America illegal. On the face of it the Delaney Clause appears reasonable enough as it requires that all food which contains a substance that induces cancer when ingested by man or animal is to be regarded as contaminated and is therefor illegal in interstate commerce. Certainly no Congressman is going to be so foolish as to "vote for cancer" so the clause was passed. When the full impact of the clause, its lack of specific definition, its all encompassing coverage of man and any or all animals - vertebrate or mollusc or insect - of all doses, over all times, ages and durations of exposure became fully appreciated, those responsible for administering the law wrung their hands in frustration and continue since so to do.

The Delaney Clause actually prohibits the interstate shipment of all meats and fish, all dairy products, eggs, all fruits, all vegetables, all cereals and what else is there to eat. Why? Because all foods contain carbon, and a minute portion of all carbonaceous material comprises radioactive carbon 14: all radio nucleotides are carcinogenic at some level, therefor Delaney forbids them at all levels. Since 1945 meats and dairy products (including human bones) have contained strontium 90, a radio nucleotide, which never existed on this planet until the first atomic bomb was exploded at Alemagordo, New Mexico. Now no boned creature alive is free of strontium 90 albeit at miniscule and insignificant levels. Thus all animal food products become illegal in interstate commerce, under this absurd law.

There are also a number of elements and compounds in foods which though toxic and even possibly teratogenic or carcinogenic in excessive dosage at one end of the scale are, at modest and useful doses, essential nutrients at the other end of the scale. The important vitamins A, D and B_{12} are in this category as are the elements iron, magnesium, manganese, selenium, copper and possibly molybdenum.

The Dose-Exposure Concept

The basic point of contention between the hysterical opponents of all chemical food additives, fertilizers, pesticides, etc. and qualified knowledgeable scientists is that of dose-exposure, the concentration of the applied or added chemical related to the route and duration of exposure of the host. The scientific concept is that for every compound and element there is a dose-exposure below which no effect for any given living organism occurs regardless of dose, time or route of exposure, this value, which obviously varies for different species and even may vary for age and condition of each species, is termed the THRESHOLD DOSE. Above the threshold dose biological effects develop. These effects may be deleterious or they may at first be beneficial in terms of growth, efficiency, health, etc., but as the dose-exposure continues to be raised another point occurs where the benefits become replaced by undesirable effects and toxicity develops. Ultimately all substances become toxic and deleterious when the dose exposure becomes sufficiently elevated.

This concept, first enunciated some 300 years ago by Paracelsis, an Italian physician and chemist, says:- "THE DOSE MAKES THE POISON" - and this remains today as the basic axiom for all medical and veterinary clinical practice and for all feed additive, nutrition and pesticidal applications made by the farmer.

But the opponents of the use of chemicals in the production, protection and processing of our food and fiber reject this basic concept and they insist that any substance which is toxic at any level, particularly if it is carcinogenic, teratogenic or mutagenic, must be regarded as so at all levels and by virtually all routes of exposure.

This is the fulcrum of contention today as to the use of chemicals in the environment of modern production agriculture, and unless it is resolved both in the minds of the people, in the halls of Congress and in the State Legislatures there appears to be little hope for a return to the complete scientific method in the resolution of such agricultural problems as optimum nutrition of crops and livestock, adequate protection from predators, parasites and disease and preservation of stored, processed and frozen produce during its distribution.

The Farmers Contribution to the Food and Fiber Environment

It is precisely in the area of food supply, where the American farmer has made his most substantial contribution to the environment of man. In the face of an overwhelming population explosion he has provided an abundance of high quality foods at the lowest cost in the history of any nation since time began and he has done it with the smallest proportion of the working population of any country on earth. He has produced 1,500 lbs. of foodstuffs per person per annum, in a broad array of kinds and types for all seasons, at a price of less than 17¢ of the take home dollar, and he employs less than 5% of the working force to do it.

This means that not only are we the most abundantly and best fed nation on earth, but we retain over 80% of our income and over 90% of our working people for use on those projects, goods and services other than for the bare necessaries of life. DeGraff has stated "The culture and wealth of a people is inversely proportional to the time and effort required for their subsistence." Today in America, the farmer has contributed more substantially to our human environment than any other single discipline including medicine, engineering, education, industry, business, law or politics.

For agricultural science, integrating the work of many people of varied disciplines has, within a political framework of freedom of thought and freedom of enterprise, brought abundant, nutritious, safe and low priced foods to hundreds of millions of people both in this country and beyond our shores.

The farmer in the western world has brought mankind to a unique point in time. In concert with the agricultural scientist he has found the way to banish hunger from the earth. In past centuries mankind lay hungry and oppressed, under the yoke of tyrants who sustained their wealth and power through the conquest, slavery and subjugation of peoples. Today our farmers have shown that the needs of mankind can be filled by the scientific and technical exploitation of the world's resources to the greater majesty, dignity and benefit of all men everywhere. This has been the towering contribution of the farmer to the environment.

Such exploitation, however, cannot be a one-way operation but must involve the recycling and the renewal of all inputs, that we live off the interest of our resources and not consume the capital. The farmer has long appreciated this obligation, and those who have not have failed. Industry and indeed the non-farming population, as a whole, has yet to learn this basic law of the universe.

In this time, the last quarter of the 20th century, mankind will confront a challenge unequaled in gravity and hazard to the integrity of the environment. Actually all the strife of war from Attila to Hitler, all the misery and want of the Dark Ages combined, will not even approach the unparalleled loss of human life which may well ensue between now and the year 2000. At least two billion people are threatened with starvation and quite possibly one billion will actually succumb to hunger and its sequelae within the next 30 years. Today over 12,000 humans die of starvation daily, which aggregates 4-1/2 million per year. The Paddock Brothers in their book "FAMINE 1975" predict this number will increase tenfold by 1980.

A catastrophe of this magnitude is virtually beyond the reach of the human mind to comprehend. But as Dawson (1969) has said, "In famines, the frail structure of civilization disintegrates. People who are hungry do not keep treaties nor the peace nor will they stay within their boundaries, they will sell their very liberty for food, they know no God but food, no country but that which will give them momentary surcease from their hunger." The repercussions of such a "tragedy of the commons" will inexorably sweep like some monstrous tidal wave across every land, into every city, town and home and affect every man, woman and child on earth. The total desecration of the environment will defie description.

Regardless of the present and hopefully sharply increased efforts of the medical profession, the social scientists, the theologians and the politicians to find, develop and widely disperse an acceptable and effective birth control method and mechanism - a "peoplostat" - the population of the world will exceed 7 billion by year 2000, and that of North America 400 million. It will be largely concentrated in Asia which will embrace over half the world's people or as much as 3-1/2 billion. Unless the food production of the world can hold a finger in the dyke by feeding these burgeoning billions until the peoplostat takes effect and holds the world population at a steady state, civilization and the environment as we recognize it today will collapse.

The only hope on earth are the farmers of the world and it will be the western farmer that must lead the way. He has, of course, already done so, in this century, and has provided abundance beyond the wildest optimistic predictions of but sixty years ago. Twice in this century he has won world wars and after each stifled the famines that threatened the vanquished. Now he confronts his severest challenge and he remains the last great hope on earth for the survival of mankind.

Why then is the farmer continually accused of desecrating the environment, destroying the natural process and producing tasteless, contaminated, unnutritious food at a high price? There is an old country maxim which says "nothing is forgotten quicker than eaten bread," and apparently it aptly applies to the American farmer. Actually our food supply is of the finest quality, the least contaminated, the most nutritious and the lowest priced on earth, but the urban and suburban people simply do not believe it. They have been inundated and thoroughly brainwashed by the press, the radio, TV, and other communications media which insistently promote the obtuse, illogical, unfactual and essentially irresponsible ideas of a vociferous few who, as self appointed custodians of the public welfare, suckle at the breast of publicity with the exuberance of a newborn babe.

There are innumerable meetings, conferences and conventions where the present status and new developments in scientific agriculture are brought to light, but they are seldom publicized beyond the related professional groups involved; there are literally hundreds of thousands of papers, pamphlets and bulletins issued by the United States Department of Agriculture, the state agricultural experiment stations and the land grant colleges and universities describing new techniques in farming, food processing, cooking, nutrition, pest control, public health and myriad other subjects, but the general public seldom, if ever, reads them and the critics of agriculture only use them to quote them out of context and establish justification for their unfair and denigrating criticisms.

By far the most important task that lies before all farm organizations such as the Farm Bureau Federations, the National Livestock Feeders Association, the Fertilizer Institute, the National Agricultural Chemicals Association and the dozens of other farm and agribusiness organizations is to assemble the real scientific facts in plain understandable form and bring them to the great mass of the non-rural people by every possible medium and in unmistakable clarity.

It is quite clear now that the prediction stated by Don Paarlberg, the distinguished economist at Purdue University, is true that, in the future, governmental decisions which affect farmers are to be dictated by urban and suburban political pressures rather than by the needs and wants of the farmer himself. This correct assertion therefor demands that the true facts about agriculture, its science and its practise and above all its contributions to all men everywhere be impressed in no uncertain terms upon non-farming people.

The U. A. W. goes on strike and makes no automobiles for awhile and few people worry; the railroad unions stop work, the teamsters union strikes, the telephone operators quit, an airline or two may go out for a spell and somehow the country bumbles along at least for a period; but have you ever considered what a fantastic impact there would be if the nation's farmers decided to produce only enough food for themselves and their immediate neighbors for a whole year, or even just for six months, or suppose there was a terrible blight which destroyed _all_ our grain supply.

Surveys conducted by Civilian Defense a few years ago revealed that, at that time when surplus foods were considerably more abundant than they are today, there was, on average, only sufficient food in reserve to last for from two to three weeks at current rates of consumption. Of course, severe food rationing would become mandatory all over the nation, but even so, the supply would not last more than six months, and where and to whom could we go to tide us over? Do you suppose India, China, South America or even Russia could or would help us? How about Cuba? Canada, Australia, New Zealand and South Africa could and would help for awhile and might perhaps actually pull us through but only at an insuperable and irrecoverable loss to all our people.

It is essential to convince our urban folk that the injury to our environment by impeding agriculture is infinitely more disastrous than any of the alleged and generally exaggerated claims as to the impairment of the environment through agriculture.

There are four areas of the environment wherein agriculture plays a role whether it be beneficial or harmful.

These are:

1. The Air or Atmosphere
2. The Land or Lithosphere
3. The Waters or Hydrosphere
4. Living Things or Biosphere

All four are, of course, intimately related and any factor affecting one will generally also affect the others.

Air pollutants

1. The Air or Atmosphere

Of the more than 200 million tons of air pollutants it is now estimated enter the atmosphere over the North American continent each year at most only 5% or 11 million tons can be ascribed to agriculture most of which are carbon and nitrogen compounds issuing from animal and other solid wastes. As these effluvia are spread out over vast areas they cannot in any way be regarded as general hazards.

In fact industrial, municipal and auto exhaust air pollution contributes abundantly more damage to agriculture, estimated by Warren Shaw (1970) as at least $50 million per annum and chiefly attributable to impaired crop production than does farming itself.

Although the total weight of agricultural chemicals which become airborne through farming operations is very small, they may, in certain cases of misuse, constitute local hazards because of their powerful activity.

Thus the chlorinated hydrocarbon pesticides such as DDT have been frequently accused of contaminating the atmosphere through drift during application and through evaporation from sprayed surfaces. Again this is largely gross exaggeration as, firstly, the amounts involved are miniscule in quantity and therefor are biologically insignificant and, secondly, most of the organo chlorine pesticides, particularly DDT, are quite sensitive to ultra violet light and therefor degrade to relatively innocuous compounds while airborne in such thinly dispersed dilutions. Such organo phosphates, as parathion, are also volatile and though severely toxic to wildlife and humans which approach recently sprayed crops, they diffuse outward from the treated areas and their concentration rapidly declines to safe levels as they become swiftly degraded.

There are authentically reported cases of some of the volatile herbicides, such as 2 4 D drifting as spray and vapor over sensitive crops and eliciting severe damage, but again the hazard to man and wildlife is negligible. The recent sensational flurry over the alleged propensity of the useful brush herbicide 2 4 5 T to induce monster offspring in exposed pregnant females is both untrue and absurd. The facts, in this case, are that the phocomelia observed in the offspring of the experimental pregnant female mice occurred as a result of massive exposure, several thousandfold to that likely to occur in the field and, now it appears, this was actually due to a contaminant in the particular batch of herbicide employed and not to 2 4 5 T at all. Yet this misinterpretation has resulted in the withdrawal of this useful agricultural chemical from several important applications.

In former years it must be admitted that some farmers in some areas did contribute substantially to air pollution. This was primarily during the sad days of the dust bowl and the clouds of airborne soil that literally darkened the sky over our eastern cities in the mid 1930's. This was indeed a shameful epoch in our agricultural history, and it arose as a direct result of our neglect of the relation of farming to the environment. But with the guidance and leadership of such men as Hugh, Hammond, Bennet, Christ, Lowdermilk, Lamb and others, we quickly resolved the problem by sound soil conservation practice which once again reestablished and restored the integrity of our soils.

The sun and the blue sky may still be frequently obscured over our eastern cities on cloudless days but it is now no longer the fault of the farmer but due to the smog generated by industry and millions of automobiles.

On the contrary the farms of America contribute immeasurably more to the depollution and purification of our atmosphere through the open space they necessarily maintain and the crops, orchards, woodlots, pastures and other verdure they produce. Virtually every molecule of life-giving oxygen in our air was placed there by living plants. Until the green plants appeared on this planet there was no oxygen in the atmosphere at all. It is still due to the green plant that the concentration of oxygen remains at approximately 20%.

As each square mile of earth surface is covered with asphalt or concrete or stone highway, parking lots, runway or buildings so is the potential maintenance of oxygen in the atmosphere impaired. As each acre of verdured land is replaced with desert, the production of life-giving oxygen is curtailed. For although the algae, or phytoplankton, in the oceans also contribute 30% of the atmospheric oxygen, it is the land based plants which are the major and deciding factor.

My colleagues Drs. Stout and Christ have computed that an acre of orchard producing 1,000 bushels of apples in a season contributes 3.5 tons of oxygen to the atmosphere. Other crops such as corn, soybeans, alfalfa and forage grasses would contribute at least as much or more per acre per year.

Thus apart from the aesthetic value of gardens, parks, woodlots and farms around cities, scattered through suburbia and surrounding industrial sites there is also the substantial contribution to air depollution from green plantings.

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It is estimated that it takes about ten 30 foot trees to convert the carbon dioxide issuing from a single automobile in a day back to oxygen. On this basis we presently need at least one billion such trees growing actively in America just to take care of the carbon dioxide pollution from automobiles alone. As most of the trees and other plants do not photosynthesize to any significant extent in the winter months, and as both cars, industrial and heating plants operate intensively at that season the total margin of safety to return the effluent carbon dioxide is not substantial, and certainly should not be impaired any further by reducing plant growth and increasing the number of cars.

Many scientists are deeply concerned today that the concentration of carbon dioxide in the atmosphere has perceptibly increased during this century, primarily due to the profligate use of fossil fuels - coal, oil and gas. Some contend that this increasing envelope of carbon dioxide, because it traps heat, will cause the mean temperature of the earth surface to rise perhaps one to two degrees F. Should this occur the polar icecaps will commence to melt as each summer thaws a trifle more ice than each winter deposits. Should this occur then the level of the oceans will rise and ultimately inundate 90% of the present major cities in the world.

Other scientists contest this foreboding prediction and contrariwise contend that solid pollutants such as smoke particulates will produce a reflective envelopeto the sun's rays and so prevent sufficient heat reaching the earth's surface. This will then result in more ice forming each polar winter than in summer thaws, and initiate another ice age; which would, of course, be equally disastrous.

Despite these contrasting contentions there is no question that massive air pollution can disturb the thermal balance on the planet, and that a minute shift up or down in mean surface temperature over a prolonged period of years could result in catastrophic changes in the biosphere of which we also are a part.

The important point here is that the maintenance of open space devoted to plant culture is the most ameliorating factor in sustaining this delicate balance, and the farmer's fields, crops and husbandry are the major forces in its achievement.

2. The Land - or Lithosphere

In the early years of America as the new settlers began to cut out their little farms from the edges of the great forest primevil, there was small concern for the impact on the environment. The immediate need was for food, shelter and raiment and every effort was exerted for their swift production. Soils often were misused and became worn out, infertile and eroded. Then the settlers would move on generally west and south and hacked out another patch to farm, often burning vast areas of prime forest to gain it.

The onslaughts of the great lumber barons who cut over the forested hills and mountains in mile wide swaths leaving the naked soil to the wash of rain and sweep of wind constitute perhaps the most outrageous insult to the environment. There are records of similar desecrations in Palestine, in Greece, in South and Central America but none were on the scale executed in 19th century America.

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After one hundred years floods, silting and sedimentation which still occur are the inevitable result when the structure of the soil is shattered. At least forty million acres of fertile American topsoil have been irrevocably destroyed and much of it swept into the ocean over the past 150 years.

Had this inordinate waste of our most precious resource not been substantially reduced but allowed to continue since the 1930's, this nation would be hard put to it today to feed itself. When Bennet and his co-workers finally reached the people and the government with their anguished outcries and appeals for action, there was little soil conservation contour farming, green manure cover cropping, or farm catch ponds to be seen in America. Over the past thirty-five years, however, remarkable progress has been achieved, and today the face of the land has been preserved and conserved. Many of our streams and rivers still run muddy following heavy rains, but much of such erosion now comes from construction sites of plants, housing developments and highways.

Here again the farmer and scientific agriculture contribute to the environment. From forage and turf research labs have issued varieties and strains of plant covers for roadside shoulders, banks and cuts, new fast growing grasses are quickly sown around building lots to hold the errant soils. Herbicides and chemical growth regulants have come from agricultural research and agribusiness to sustain the integrity of drainage and irrigation ditches without impeding water flow.

Recent research has reestablished the long known farm use of waste organic residues, animal, food processing, industrial and municipal, applied to the soil. For although it still can not be shown that crops necessarily are superior when dressed with organic wastes as compared to inorganic fertilizers alone, the moisture, heat and mineral absorbency of the soil is substantially enhanced. Actually, regardless of the relative economics at the moment, there simply does not appear to be a reasonable alternative for disposing of organic wastes except to work them into the surface soil.

The recent furor over the use of mineral fertilizers on the cropped soils is essentially an exercise in futility. Without supplemental nitrogen, phosphorus, potash and lime our crop yields would in total so decline as to result in general starvation. Even were all the animal manures plus all the municipal processed wastes applied uniformly over all our arable lands this would still only provide about 15% of the actual levels of fertilizer now applied. For, as Wadleigh has pointed out, we have lost close to one billion tons of natural soil nitrogen in 200 years and have replaced not more than one-tenth of that amount. Our soils are therefore, in many areas, actually polluted with infertility.

The claim that artificial fertilizers are leaching toxic levels of nitrates into the aquifers and poisoning babies is both utter nonsense and culpable irresponsibility. Extensive monitoring of rivers and streams through numbers of drainage basins among mid-western areas intensively farmed reveals neither toxic accumulations nor trends towards them.

The prime cause of nitrate nitrogen in free running waters and deep aquifers appears more to be due to septic tank and animal feed lot effluents than to applied nitrogenous fertilizers. There is, in fact, evidence that fertilized crops allow less nitrate to leach to below 2-4 feet than do unfertilized soils. This apparent paradox is due to the much enhanced root growth among fertilized plants which absorb the nitrates greedily and thus interdict their descent.

The farmer therefor improves the soil and the land environment by removing undesirable growth, and cultivating desirable plants; by contour farming he prevents erosion and enhances water penetration to the water table; by returning organic wastes to the soil he can solve two problems simultaneously, degrade wastes and improve soil texture, condition and tilth; by applying inorganic fertilizers he restores lost fertility to soils many of which are actually polluted with infertility.

3. The Waters or Hydrosphere

The farmer is often blamed for polluting the rivers of the land with soil and with chemicals, chiefly fertilizers and pesticides. Careful monitoring surveys for both nitrates and pesticide residues reveal that most of the river waters, examined over a period of eight years now, which drain agricultural areas do not reveal an accumulation of either nitrate nitrogen or of pesticides.

Thus, for example, present nitrate levels in the Wabash River near Lafayette are essentially the same as those recorded in 1910.

Enfield (1970) has made a broad spectrum survey of many river basins in the middle west and found no indications of nitrates rising to undesirable levels.

Where high nitrates in waterways have been noted they are invariably traceable to feed lot runoff or to municipal, industrial and septic tank effluents. Such sources are also found to provide the soluble phosphates which with nitrates promote the serious algal blooms and eutrophication which follows. Fertilizer phosphate is rapidly fixed by soil, and except for the occasional rapid wash-off from heavy rains, farm phosphates seldom reach drainage waterways. Detergent phosphate employed in homes and industry for cleaning purposes, however, does reach the river outfalls through sewage disposal. Even so, most of the soluble phosphate is rapidly fixed by iron, aluminum, calcium and various organic compounds with which it comes into contact.

One area of research which can be derived directly from the disciplines of scientific agriculture to aid in resolving the mineral contamination of water is the study of algae or limnology. These minute green plants were the first form of life on earth and remain today one of the most important in the biosphere.

They can materially aid in water depollution by controlled culture in water processing plants. They will both remove excess minerals from the polluted water, aerate it with the oxygen they evolve and produce a nutritious and abundant feedstuff for livestock, which would be non-competitive with man's food supply. The total agricultural, municipal and industrial wastes produced annually in the United States could produce enough 40-45% protein feed for livestock as the present total yield of soybeans, which could then be redirected to the feeding of mankind.

There is also the avenue of cultivating algae on sewage, zooplankton on the algae, krill on the zooplankton, dace or carp on the krill and finally bass or trout on the dace ending with a nutritious and acceptable fish food for either man or livestock. Aquaculture will some day become as important a source of food for both man and animals as is agriculture today. It will, however, emerge from the science of farming and constitutes the promise of a major contribution of the farmer to the environment.

The alleged contamination of the hydrosphere by pesticides, also primarily blamed upon the farmer, has developed into a national near hysteria. Exaggeration out of all proportion to the facts is the keynote of this absurd campaign. It is not possible to go into the total subject here, but suffice it to say that monitoring studies of the great river estuaries that drain over 90% of the farm lands of the nation reveal no significant concentration of any one nor any group of pesticides either in the flowing waters or in the benthic deposits beneath. Repeated samplings indicate concentrations of individual pesticides in the parts per trillion range, which is an accolade to the incredible precision of our modern analytical techniques rather than a warning of the terrible disaster to come.

Only where direct industrial effluents from pesticide manufacturing plants have been inadequately controlled and heavily contaminated wastes have been allowed to issue, have the monitoring assays revealed undesirable or hazardous levels. These cases, again, are ones of misuse rather than normal hygienically approved practice.

Thus in his use of the hydrosphere the farmer improves the environment. He recycles the waters through the soil by irrigation; he reduces the levels of eutrophigenic minerals by soil absorption and ultimately into production crops and livestock; and he maintains a more uniform river and stream flow by slowing the wash off and percolation of waters during the thaw of snow or the drench of rain.

4. The Biosphere

Those who contest the works of the modern farmer make their case primarily on the ground that monoculture ravages the ecology and therefor seriously disturbs the environment. This argument is necessarily mounted upon a number of dubious and quite subjective assumptions. It presupposes that monoculture is a man-made ecosystem, when, in fact, nature has evolved great areas of monoculture, albeit that man's is more concentrated and controlled. It also must argue that culture of a multiplicity of species is intrinsically better than the culture of but a few; but better for whom? Man's approach to his ecosystem is man-centered or anthropocentric, and understandably so.

For certainly the only meaning of the term "conservation" is to conserve man plus all those plants and creatures of the planet which serve man and contribute to his aesthetic fulfillment. Any other point of view is really not "conservation" but conversation.

This is probably the toughest bone of contention between the agricultural scientist with the farmer and with the conventional conservationist on the one hand and the recently emerged ecosystematologists, naturalists, wildlife preservationists and anti-chemical, anti-industry, anti-establishment cohorts on the other hand. The only possible way to settle these arguments, which at the moment are essentially subjective, is to amass irrefutable objective evidence as to the real impact of modern monoculture on the desirable biosphere, and then draw conclusions.

Obviously there are many living creatures on this planet, the decease of which no one would mourn. We could all live without the smallpox virus (and many other injurious viruses), syphilis, tuberculosis, malaria, the Anophelene mosquito and myriad other obnoxious vital agents. But there is also a wide twilight zone wherein reside numerous creatures which although not important to all are cherished by many and clearly should be preserved.

The most obvious solution to maintaining a pool of biotic germ plasm, which must be regarded by man as a priceless asset, is to provide large areas of containment on every continent where all known species of plant and animal can be preserved in their pristine state and protected against the thrust and pressure of modern man. This would be an ideal project for the United Nations' UNESCO.

The required data that assesses the actual impact of modern agriculture on wildlife has begun to come in and although, as yet quite incomplete, does indicate that for many and possibly most favored wildlife, the farmer enhances their growth and survival.

Spencer has made a large-scale survey of wildlife counts over the past quarter century and finds most prized species are thriving in areas where farms predominate.

On the other hand the encroach of the city and suburban sprawl has clearly pressed many hunting birds, such as the raptors, into near extinction or driven them further back into the remaining but shrinking wilderness.

The evidence that such declines as are noted in the peregrine falcon, the goshawk and the bald eagle are due to the use of pesticides by farmers is both equivocal and exceedingly debatable. There is probably more concrete evidence that pesticides applied by farmers, by mosquito abatement districts and by public health sanitarians concomitantly reduce insect borne wildlife diseases even as they suppress insect vectored human diseases.

Perhaps eventually we will develop highly sophisticated biological pest controls which will substantially reduce the need for pesticidal chemicals, but until that utopian day comes we must recognize that every crop and every livestock species raised by our farmers is prey to some two or more dozen parasites or diseases, and that without a reliable, effective, safe and economically valid instrument to protect his produce the farmer could not possibly meet our demands upon him for food and fiber.

There are actually more than 10,000 pests which plague our economic plants and animals or threaten our public health and comfort. Of these 10,000 at least 3,000 are of constant concern with which our farmers must be continuously prepared to cope. There are not more than 100 pests for which we have biological controls including resistant strains, management practice and helpful predators. There are at present no more than 30 reliable biological controls against important insect pests of crops, forest trees and livestock.

Obviously the farmer who must continue to provide abundant, high quality, low cost food and fiber for the nation, unblemished and unsullied by insects, disease and vermin, cannot possibly meet his obligations to the public without the continued help of chemical controls. Furthermore, when registered and approved pesticides are applied correctly in strict accordance with label recommendations there is not any reason why he should not use pesticides. For when applied properly they are safe, effective and economically sound. Their contribution to the integrity of man's environment is immense compared to the probable damage they are often alleged to elicit.

CONCLUSION

Modern growers and ranchers are fully aware of the necessity to be in tune with the environment in their farming operations, for they know they cannot sustain their soils, their crops or their livestock at a profitable status unless they observe and obey the basic laws of environmental science.

The great civilizations of antiquity perished because the husbandmen of those bygone days failed to obey these fundamental laws. As Lowdermilk has recorded the ancient cultures of Egypt, Nineveh, and Babylon, of Greece, Rome and Carthage and of the Incas, the Aztecs and the Toltecs of Central and South America failed and perished because their farmers abused rather than nurtured their environment.

There has recently been advanced the argument that environmental pollution is the inevitable product of the Abrahamic concept of husbandry as expressed in the Judeo-Christian ethic and teaching. This is both unjust and irrational particularly as most of the past civilizations which fell by self destruction of their environment either preceded the Judeo-Christian era or were totally unaware of it.

The pressures upon environmental quality arise from the demands for food, for raiment, for shelter, and for living and recreation space of the burgeoning billions of human beings that constitute the population explosion, that consume vast quantities of natural resources, that generate mountains of detritus and wastes and that insist that their numbers, their ravening consumption and their indifferent desicration of the environment, be allowed to continue to grow in exponential volume.

Perhaps the American farmer is to blame, in part at least, in providing such a plethora of foods and goods that he has substantially contributed to the good life for so many that, becoming freed from the restraints of hunger and want, the people have followed

Thomas Malthus' prediction that providing easy access to the necessaries of life would "encourage --- the abandoned frenzy of their own propagation --- which would ensure that man would always wallow under the demographic pressures generated by his own lack of caution and restraint."

To accuse and condemn the farmer for denigrating the environment is, of course, both ungrateful and unfair; but I suppose in this day of political targets his receded numbers assures his selection. He has, however, three insuperable factors on his side:

1st. The Hunger, the Want and the Sufferance of Mankind which he alone can resolve and which assure his place in our community regardless of its political or social complexion.

2nd. The eternal Hostility of the Natural Environment, that is "red both of tooth and claw" and cares not either when or how man dies as long as he does.

3rd. The Truth, the Assurance and the Security of the Science of Agriculture and the Environment which can and shall resolve all problems of the Future as it has all problems of the Past.

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THE ECOLOGICAL AND ENVIRONMENTAL EFFECTS OF AGRONOMIC CHEMICALS

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INTRODUCTION

The National Science Board (NSB) of the National Science Foundation (NSF) in a recent report submitted to the President: "Environmental Science:Challenge for the Seventies" included a rather arresting statement which delineates with clarity the dilemma of our civilization, as it increasingly exploits the natural resources of the planet and exhausts the normal recycling processes which formerly effectively and continuously restored the environment.

The report states-
"Modern civilization has reached the stage where no new use of technology, no increased demands on the environment for food, for natural resources, for areas of recreation, for places to dispose of the debris, can be undertaken without a high risk of injury to others. The best that can be sought is to optimize, to try to achieve the wisest cost-benefit decision for society for each action."

This statement confirms the general conclusions derived from the Aspen, Colorado Conference on "Technology:Social Goals and Cultural Operations" (McElheny 1970), which noted that with the human population as it now stands, let alone what it will reach by the 21st century, the exploitation of the world's resources by the so-called developed nations is at such a high level at the present time that it is quite unfeasible for the emerging nations to attain a comparable standard of life. The consumption of power, heavy metals, water, food and land by the advanced nations is now so extensive that it cannot be approached by the emerging nations without a concomitant substantial retrenchment in the use of natural resources by the western world. In a word, it becomes quite impossible "to raise the poor up without bringing the rich down."

Historically the "haves" have always resisted the encroachment of the "have-nots" poaching upon their preserves and, in spite of the philosophical exhortations of various misanthropic prophets, it seems most unlikely that Americans, Europeans and Australians are going to give up flush toilets, electric power, automobiles and a meat dietary merely to improve the lot of natives in New Guinea, Nepal, Kenya or Terra del Fuego.

The alternatives are not, however, as we have been led to believe, so stark, inexorable and absolute. There are ways and means of enriching the lot of all mankind without necessarily enforcing those who have already advanced to be the poorer withal.

As Sir Peter Medawar pointed out, "There is a tendency today, even a perverse willingness, to assume that the despoilation of nature induced, on occasion, by technology is an inevitable and irremediable process, a very trampling down of nature by some big inexorable machine. Actually, of course, whatever the deterioration of the environment induced by technology may be, it is, in fact, a technological problem for which science has either already found or will shortly find an appropriate solution." It is utterly futile to complain about the denigration of the environment when the obvious need is to seek and apply adequate regulation of the unwanted side effects. It is clearly unrealistic and ridiculous to collate inaccurate, exaggerated, irrelevant and too often emotional evidence to ban the correct, safe and established uses of agricultural chemicals, when the overwhelming facts dictate that our food supply, our health and the entire measure of our living standards would indubitably be threatened and impaired by such rash and ill-considered legislation.

Perhaps the major reason for our failure to attune environmental adjustments into our new technologies in order to optimize the benefit:hazard balance lies in the fact that our technical disciplines operate largely in isolation without any particular regard to the interrelation between disciplines, between technologies and, most importantly, between humans who will apply the new technology and the particular environment within which they will make the application.

This concept is clearly recognized in the NSF report mentioned earlier, where the interdepartmental, multidisciplinary integrated research approach to a target program is applied and where all the significant environmental aspects are considered simultaneously investigated and the results interrelated to derive the common solution. Isolated individual scientists, working in separate disciplines on piece-meal segments of a technical problem are not likely to resolve a complex environmental situation, unless their investigations are interrelated and mission oriented.

In recent years there have been many incidents where a few isolated studies, quite unrelated to the total environmental situation, have been reported and often circulated into the news and TV media, before they could be objectively assessed by the scientific community. These have generated an overwhelming hysterical public reaction which too often has been the deliberate objective. Many of these unfounded, and frequently experimentally unsupported, opinions have been foisted off on an unsuspecting public, who over the years had grown to trust and rely upon the statements of scientists as facts. When well trained and qualified scientists issue unqualified statements, which they surely must know are not factual, the scientific community as a whole inevitably suffers from the credibility gap thus created between itself and the public. Eventually, of course, each of these hyperbolic statements become discredited before the inexorable accumulation of experimental evidence but, before this occurs, too often irreparable injury is sustained by the public, by science and by the environment.

The field of agricultural chemicals has, for some years now, been a particularly popular target for derogation, among those who prefer to ignore the contribution fertilizers, pesticides, feed supplements and medicaments have made, not only to the farmer, but, more importantly, to all mankind and to most of the environment. Herein, of course, lies the chief bone of contention. To certain denizens of the environment agricultural chemicals have admittedly been, to say the least, non-contributory to their welfare or even survival. Over millenia for man to survive, to proliferate his species and to advance his security, his longevity and his standard of living, trade-offs against competitive species in the biosphere have been inevitable.

The same, of course, has also been true for all species that sought hegemony over others. The singular difference is that man has overwhelmingly succeeded first,because he employed intelligence rather than instinct. second, because he found a way of life and the tools to transfer to succeeding generations his accumulated knowledge and experience and, third, because he developed rapid and extended communications to pass information, supplies and implements from one person to another and from place to place. Certain other species also have some of these assets, but no other species has all of them.

There are some ecologists who contend man has no more right to the resources of the planet than any other species, and that he has taken unfair advantage of his assets to subdue and exploit virtually every other living thing and the environment to his own questionable ends. This is, of course, largely true but so far as man is concerned life is anthropocentric (or man centered) and his major concern for all other species of life is related to how they affect him, beneficially or deleteriously. Those that toil and serve him, that feed and clothe him, that amuse and delight him, he favors, cultivates, preserves and conserves; while those that despoil and devour his food, that destroy or befoul his shelter, that attack or infect his person or that of his favored species, that irritate him and disturb his comfort, he relentlessly destroys and if possible, though rarely, he extirpates.

The environmental ethics of this attitude may be debatable but it is nonetheless real and as scientists, whose profession dictates that we must engage in these conflicts with other species, we have no other alternative but to be realistic and practicable about it. There are admittedly twilight areas in the biosphere where one man's favored species becomes another's pest - as witness the recent eagle slaughter in Wyoming - but in the main conservation - the only reasonable meaning of the term - is to conserve man and all those favored aspects and creatures of the environment that serve man. Any other interpretation is not "conservation" but merely "conversation".

For surely few would pine for the Anopheline mosquito or its burden of malarial plasmodia, for syphilis, for smallpox, polio, or rabies viruses, for poison ivy or dodder, for Jap beetles or gypsy moths, if these and myriad other noisome pests were eliminated from the planet. Yet it can equally be argued they serve some purpose in the environment, obscure to most men though it may be. We must not only be ecologically conscious but also practical, exercising our superior talents and facility at once for the betterment of man and his environment.

To a large extent this has been done by modern scientific agriculture. In North America where 5% of the population produces for the remaining 95%, the most abundant, varied, high quality food, fiber and shelter available anywhere in the world or since history began, and does so for less than 20% of the gross national income, agriculture has become the foundation upon which the towering structure of the nation stands.

The four pillars of this foundation are:

1) Education and extension - to bring the findings of the research laboratory and experiment station down to the grass roots on the farm where they can be put to work.

2) Biology - to dilineate the lives and functions of useful species, particularly genetics to improve the returns from domestic crop plants and livestock.

3) Engineering - to provide power to produce, so that one man can now do what it formerly took one hundred to do.

4) Chemistry - that unlocks the secrets of life itself and provides the ways and means to increase products through compounds which promote growth and quality of useful crops and animals - as fertilizers and feed supplements - and compounds which protect the produced increments from the ravage of insects, disease and vermin - as pesticides.

It is this fourth area of agricultural chemistry to which such intense and unremitting criticism has been directed in recent years. Pesticides became the prime target, both generically and specifically, not only in terms of the chemistry of the compounds involved but basically in terms of the principles applied. Thus the thrust has been to "prove" it one way or another to the public, if not to the scientific community, that man-made chemicals are ipso facto hazardous to man and his environment, that natural chemicals are inherently safer, more effective and that natural methods of control are ethically correct and ecologically sound no matter how ineffectual, slow, costly and unreliable they have proved to be. This use of the scientific method in a pseudoscientific exercise deliberately calculated more to influence public opinion and thence, hopefully, legislation rather than to assemble objective experimental evidence has led to incredible conclusions which have evolved into a form of public paranoia directed at chemistry.

The popular acceptance and astonishing success of the first polemics against pesticides led predictably to similar literary denunciation of other areas of agricultural and industrial chemistry, including fertilizers, feed supplements, animal medicaments, etc., all of which it has been proclaimed induce disease, shorten life, ruin food, despoil the environment and affect the integrity of man's germ plasm. Researched and written by self appointed and often unqualified custodians of the public welfare, these so-called technical reports have proved to be monuments of misinformation that quote the scientific literature with a biased and subjective selectivity, that assemble "evidence" on the basis of post hoc ergo propter hoc logic assuring that all the "Science is print to fit."

Against this dilution of the scientific ethic with political expediency, there is actually small defense that the scientific community can mount. Science must await the collation of experimental evidence rendered appropriately confident by statistical reduction, and this takes much time and money to achieve. In the meanwhile new unsupported accusations are made virtually with each issue of the weekly magazines and Sunday supplements. Ultimately the inexorable tread of Science will bring all of these false claims to the bar for answer but unfortunately not before irreparable damage will have occurred.

It is the purpose of this paper to review the evidence already extant which reflects upon the benefit:hazard comparisons of agricultural chemicals, primarily fertilizers and pesticides, upon the ecology of the environment.

FERTILIZERS

For many years, actually, there has been opposition to the use of inorganic man-made fertilizers, but, until recently, these critics have been confined to fringe groups with influence neither in scientific nor political circles. Such soil amendments have become an integral factor in maintaining soil productivity as the increasing intensity of crop farming exhausted the fertility of virgin soils. Organic manures and detritus sustained the deficiency for a while but, as livestock became redistributed and largely separated from intensive crop production, the use of inorganic fertilizers inevitably increased, so that today they constitute an essential input in modern crop practice. The literature is replete with many thousands of scientific papers attesting to the essential need for fertilizers in the production of food and fiber for a burgeoning humanity.

Tanner (1968) made an extraordinarily pertinent study of the use of nitrogenous fertilizers and the related economic development among various nations. He clearly showed the direct and highly significant correlation between the fertilizer nitrogen equivalent diet (FNED) and income for some 19 countries. As income rises in relation to FNED it approaches a steady state around 80 lbs. of N/cap/annum.

Based on FAO and WHO standards for human protein requirement of 70g protein/cap/day, this becomes 55 lbs. protein/cap/annum or 8.8 lbs. of N/cap/annum for a bare subsistence diet. Assuming one quarter of this protein nitrogen is in the form of animal protein with a conversion efficiency of 15% and the other three quarters is plant protein with a conversion efficiency of 50%, this computes to (2.2/0.15+6.6/0.5) to 27.8 lbs. of fertilizer N/cap/annum. Extended over 3.5×10^9 humans this aggregates to approximately 50 million tons of available nitrogen per annum to feed and clothe the world's population at a bare subsistence level. This is roughly three times the present world production of inorganic fertilizer nitrogen. From this must be deducted nitrogen precipitated by rain, dust and other fall-out, physical and biological fixation and organic manures and wastes. Uncertain as this figure is, it probably does not exceed twenty million tons of N per annum, which leaves at least thirty million tons required per annum for bare subsistence of all the world's people.

This would allow no contingency against crop losses from flood, drought, frost, insects, disease or weeds; it would provide no carry over for future crop or livestock failures and it would leave nothing to export to hungry peoples in times of emergency. This surely delineates the narrow margin of security by which mankind stands even with the added protection of man-made fertilizers and pesticides.

The diet of America is, of course, considerably above bare subsistence in terms of protein, being on average over 100g/cap/day, of which at least 70% is animal protein. In addition, even with the use of the much maligned pesticides, losses to pests aggregate at least 10% while flood, drought and windstorm losses are about 5% nationwide and another 5% is required for carry over. This aggregates to a total fertilizer Nitrogen Equivalent of 81.2 lbs./N/cap or a total of about 8.4 million tons of nitrogen per annum to maintain the food supply of the present U. S. population at the current average dietary level. To this must also be added some 850,000 tons of N per annum for cotton and other fibers, and at least another 500,000 tons of N per annum to maintain home gardens, lawns, parks, golf courses, highways, turf farms, etc., for a grand total of 9.75 million tons of N/annum. Total current annual U. S. production is approximately 8.0 million tons of which about 6.0 million tons is available to agriculture and related uses. This amounts to about 60% required to meet the food, fiber and recreational needs of the people. The balance of four million tons per annum is derived from natural fixation, precipitation, animal wastes and from the remaining reserves still available in many U. S. soils.

The virgin corn belt soils of Iowa, for example, once carried over six tons of native nitrogen per acre, yet, today, following a century of crop depletion, elution, erosion and denitrification, these soils respond significantly to applied nitrogen fertilizer. Today, on average, at least 40% more nitrogen is removed from U. S. soils than is annually returned.

Interestingly, Tanner (1968) computes that as the FNED approaches 80 lbs./cap/annum, the curve levels off and no further increase in nitrogen requirement per capita will occur regardless of further rise in income. Therefore when the maximum food needs, as protein are attained per person, further increase in fertilizer nitrogen applied to the soilarises only in response to increasing population.

The U. S. has virtually reached this stage now. There may still be a further shift from vegetable proteins to the more costly and less efficient animal proteins, although as the level of animal protein intake is already over seven times the minimum daily requirement, any further substantial increase seems unlikely.

Supplements of fertilizer nitrogen readily available to rapid crop plant growth are therefore on the critical side now and must indubitably be increased as the population enlarges and available arable lands shrink, otherwise both the dietary and the income standards of the nation will inexorably decline.

For despite the incredible expansion of industry in America, the nation remains basically agrarian with all the urban, suburban and industrial complex resting solidly upon agriculture, which in turn depends upon soil fertility and the science and skill of the nation's farmers to convert it into food and fiber. Should this base be destroyed or even just disrupted, there is no other people to whom the U. S. could turn for food and fiber to meet the levels currently consumed and the nation's preeminence in the world therefore inevitably recede.

NITROGEN POLLUTION

Public concern over nitrogen pollution of fresh water supplies has reached virtually hysterical proportions. Agriculture, through its wide use of inorganic fertilizers, is regarded as the chief culprit and serious proposals have been publicized to curtail the use of nitrogenous fertilizers by farmers. The fact however is usually ignored that without additions of supplemental nitrogen to our crop soils, yields would rapidly decline, our food and fiber supply would shrink and the price would soar; a matter of political concern not only to the administration but to the critics as well.

Wadleigh (1969) has pointed out that, in fact, many of the U. S. arable soils suffer from infertility pollution. For over the past two centuries there has been an abstraction of native soil nitrogen through crop removal, leaching and denitrification which considerably exceeds fertilizer additions by a factor of 10.

What, then, are the actual sources of nitrogen pollution of the aquifers and what is their relative impact?

Certainly the evidence is overwhelming that, in the populous and industrial areas of the country, the major sources of nitrogenous contamination are industrial effluents, municipal and septic tank outfalls and sediment wash-off from building sites, urban streets, highways, parking lots, airport runways, etc. Compared to these sources, agricultural fertilizer contributions are minor. (Frink 1969)

Thus the President's Science Advisory Council (1965) reported that 125 million people in the U. S. were served by domestic sewers, of which the output from 13 million was simply run virtually raw into convenient waterways, and additional sewage outfalls from some 30 million was discharged after only crude primary treatment, which removes no nitrogen at all. Many cities have no separate system of storm sewers or street and road drainage and in times of heavy rainfall or spring thaw the overloaded plants have to by-pass the total outfall into the receiving watercourse.

This computes to a total environmental insult equivalent to the raw sewage discharge from over 50 million people.

Add to this the septic tank or cesspool effluents from some 80 million humans, of which at least 20% of the nitrogen fraction reaches the aquifers, the total insertion of nitrates into the nation's waterways from urban and suburban sources far exceeds that contributed by agricultural ferilizers.

As the American people consume about 10 times as much animal protein as they actually require for body growth and maintenance, the bulk of the protein is metabolized as energy rather than for tissue replacement. The excess nitrogen is simply excreted, which accounts for the fact that the U. S. is at once the most affluent and the most effluent nation on earth. (White-Stevens 1966)

The USPHS has set the allowable tolerance for nitrate-N in potable water at 10 ppm, which undoubtedly is frequently exceeded in many fresh water sources. Fortunately, although the threshold minimum effect level for NO_3-N in humans has, as yet, to be critically determined, it lies at least three to five times higher than the permissable tolerance. This provides a reasonably confident margin of safety. Nevertheless there have been comparatively rare and isolated incidences of methemoglobinemia among infants, an often fatal blood disease attributable to nitrate poisoning. Although these fatalities have been excessively exaggerated, they do constitute a warning signal that nitrate contamination of fresh water supplies is a mounting environmental hazard.
(Campbell 1952) (Comly 1945) (Walton 1951) (Bosch et al 1950)

Agricultural operations also contribute to nitrogen pollution of the aquifers though to a relatively minor degree although, in certain rural localities, seepage and runoff from large stockyards and intensive livestock units contribute substantially to nitrate contamination. (Smith 1967a) (Goldberg 1970)

Nitrogen losses from inorganic fertilizer applications is a matter of considerable concern to farmers. As nitrogen is the most expensive plant nutrient he is as anxious to convert it into salable crops and livestock as are the conservationist and health officer to prevent its loss to the aquifers.

Allison (1966) reviewed nitrogen balances on various soils, in different climates under divers cropping systems and, in general, concluded crops remove more nitrogen than is usually applied as fertilizer. Van Doren et al (1950) noted in a study of corn grown under contour cultivation that the tile drains revealed a loss of about three pounds N/A/yr., an insignificant amount. This compares with an Illinois study which showed tile drain leachates from 5.4 to 17.4 ppm of NO_3-N over a two month period when the soil had been fertilized with 120 lbs. N/A as ammonium sulfate. (Welch et al 1969) Robertson (1969) reported that the above ground portions of a corn crop yielding 130 bushels of grain/A in Michigan removes 210 lbs. N/A following a fertilizer application of 150 lbs. N/A. The 60 lbs. N/A negative balance is supplied from depletion of the native soil nitrogen plus perhaps 10-15 lbs. N/A/yr. supplied from rain and fixation by soil microflora. He regards leachate into aquifers as insignificant and regards fortuitous surface erosion as the most important avenue of loss.

Erickson and Ellis (1971) reporting a recent survey of the nutrient content of drainage waters from agricultural lands find such drainage waters are remarkable low in plant nutrients, which they consider surprising in lieu of the natural amounts natively present in these soils in addition to that added as fertilizer.

Timmons et al (1968) studied the nitrogen losses from soils under five systems; fallow, continuous corn, corn-legume rotation, oats and hay. On a 6% slope surface soil losses ranged from four to ten tons per acre/yr. on open land depending upon duration and intensity of the rain. These fallow/soil losses were tenfold that for continuous corn, twentyfold that for corn-legume rotation, and three hundred-and-eightyfold that for oats. On hay cropped land no soil at all was eroded. The coincident soluble nitrogen losses were all below one lb./A/yr. except for 2.3 lbs. NO_3-N/A loss on the fallow plots in one year following a 4.63 inch rain washoff. Virtually all the nitrogen losses sustained were organic which, of course, was eroded with the soil, principally from the fallow plots (i.e. 90 lbs. N/A/yr.)

Smith (1967a) reports essentially the same results in Missouri.

The nitrogen absorption activity of plant growth exercises an astonishing curb on both the leaching and erosion of soil nitrogen. Adams (1968), working with corn and sorghum on the loess soils of Nebraska, demonstrated that nitrogen leached from unfertilized soil actually exceeded that from fertilized soils (up to 240 lbs. N/A/yr.) measured down to four and five feet. Smith (1967b) also noted a similar effect on Missouri soils and suggests that, as adequately fertilized crops flourish particularly in the root zone, nitrogen interdiction is greater and leaching the less.

Lysimeter studies by Pratt et al (1967) in California involving both sandy and clay loams, various sources of soluble nitrogen ($(NH_4)_2SO_4$; $Ca(NO_3)_2$; NH_4OH) and applications as high as 600 lbs. N/A/yr. revealed no differences between sources as to either nitrogen absorption or leaching and, curiously, more nitrogen leached from the clay (17% of applied N) than from the sandy soils (10% of applied N) under crops of sweet corn and swiss chard. This was regarded as due to the presence of a higher native nitrogen level in the clay loam, as over the five year period of the study the nitrogen removed by the crops plus leaching was 131% of the applied level on average.

Nitrogen leached ranged only from 10-20% of the applied dose even when the fertilizer applications far exceeded general practice.

It appears then that, although some soluble nitrogen is leached from well fertilized fields, particularly from those planted to short season rowed cultivars, it is, in fact, relatively minor compared to erosion losses of organic nitrogen that can accompany heavy rains, particularly on sloping lands not planted on the contour.

In general the farmers tend to restrict their nitrogen fertilizers to below the optimum for economic reasons, continuing to rely upon native residues and carryover in the soil plus receipts derived from the atmosphere. As the native sources decline further and as cropping demands intensify, farmers will have to apply additional dressings of nitrogenous fertilizers to maintain and, indeed, to increase yields. As such practices could lead to excessive leaching of nitrates into the aquifers they can, no longer, be ignored as a source of ecological disturbance. It will become increasingly necessary and economically sensible to monitor both carryover nutrients in the soil and leachates in drainage systems at least in those areas of combined intensive crop production and high population density, e.g. New Jersey.

At the present time there is no evidence that nitrogenous fertilizers constitute a general environmental hazard or serious ecological disturbance. Enfield (1970) has made an extensive survey of nitrate contamination of watersheds in the middle west and found no significant rise in the nitrate content of the major rivers and water supplies. In fact, at Lafayette, Indiana, he noted the concentration of nitrate nitrogen in the Wabash was actually the same in the 1960's as it was in the first decade of the century.

Sommers (1969) reviewing the evidence of nitrate contamination of aquifers from agricultural fertilizers, recognizes the potential of leached nitrogen as an environmental contaminant and recommends:

1. Apply Fall N. only as NH_3, when soil temperature lies below 50°F.

2. Apply Fall N. only to medium to heavy soils, never to sandy soils.

3. Apply off season N. only to soils not susceptible to erosion.

4. Incorporate broadcasted fertilizers immediately by discing.

5. On well drained, leachable soils apply N. in small increments.

6. Avoid Fall applications on poorly drained soils that may pond or washoff.
7. Avoid high level N. applications to soils subject to drouth.
8. Meter applications to crop needs - avoid excess applications.

It is obvious the nation must be fed, clothed and sheltered; to do so crops must be grown; nitrogen is an essential requirement for all crops and for economically valid production; inorganic fertilizers are the only source of nitrogen that can meet these needs; the environmental disturbance, were nitrogenous fertilizers to be withheld or substantially restricted, as proposed by Commoner (1966), would, so far as man is concerned, substantially exceed a minute rise in the level of nitrate nitrogen in his drinking water or that of his livestock or of his favored wildlife.

As Smith (1971) rather eloquently stated before the Senate Subcommittee on Pollution:

> "Present fertilizer practice is not jeopardizing our water supplies. The nation's farmers, through proper use of fertilizer are actually improving the environment, perhaps more than any other industry. If we are to meet the demands for quality food for our expanding population, more not less fertilizer will be required --- and any new policies that affect our soils should promote its use --- and not recede into the inefficiencies of the past."

PHOSPHORUS POLLUTION

There has been more public clamor and concern over pollution of waters with phosphates than perhaps any other single contaminant. Eutrophication of lakes, ponds and sluggish streams is repeatedly blamed on phosphates derived from agricultural fertilizers, household detergents and industrial effluents. Several local governments have passed laws and regulations banning the distribution, sale and use of detergents carrying phosphates, hopefully as a measure to reduce phosphorus pollution of open waters and ground aquifers. The public has been falsely led to believe that reduction or elimination of detergent phosphates will substantially curtail eutrophication and return many of our lakes and streams to their pristine clarity. Housewives are persuaded to forego their "whiter than white" wash and, for the sake of the environment, to return to "ring around the collar" and "tattletale grey."

As recently discussed in a national magazine (Chemical Week), this absurd campaign is nothing short of a gigantic public "put on"; and this was clearly the general consensus of environmental experts and public health officials in recent testimony before the Federal Trade Commission.

Okun (1971, Univ. N. C.) points out, for example, that some 85% of the U. S. population using detergents are in areas where the effluents are discharged into waters which reveal no eutrophication problem at all. The waste waters from the remaining 15% where algal and other phytoaquatic growths are a problem are so confounded with other eutrophying factors that the contribution made by detergent phosphates can only be regarded as insignificant.

Oswald (1971, Univ. of Calif.) contends from his extensive long term research on waste water pollutants that "there is no evidence that removal of detergent phosphate will perceptibly benefit the environment." In fact the pertinent scientific evidence thus far obtained is to the contrary.

Hasler (1947) studied eutrophication in some 37 lakes all over the world, varying in size from 9.4 hectares to 1.5 million hectares and related the condition primarily to domestic sewage, particularly its carbonaceous and nitrogenous components. Lake Zurich in Switzerland, for example, has become increasingly eutrophic over the past century as domiciles congregated about its shores and the population of Zurich grew. As early as 1898, long before either fertilizers or phosphate detergents appeared, Oscillatoria rubescens invaded the waters and has colored the outflow copper-red during eruptive blooms ever since. Similarly Lake Windermere in the Lake Country of England, far from fertilizer fields and long before detergents, has steadily increased its eutrophication.

The curious anomalie concerning the current public wrangle over detergent phosphates is that the alternatives proposed to date actually constitute a greater threat both to the integrity of the environment and to the public safety than the compounds they are intended to replace.

Gosselin (1971, Dartmouth Med. Coll.) notes that the caustic properties of the proposed alternatives far exceed those of the conventional detergent phosphate compounds. He points out that while the phosphates employed are entirely safe to humans, livestock and wildlife, the alkalinity of the substitutes is so high that they represent a distinct hazard. "Their accidental ingestion, by children, pets, or livestock, for example, will elicit severe corrosion of the esophagus and stomach, while strong solutions splashed into the eye would result in corneal opacities and very probably would permanently impair vision," he states. Sufficiently real are these hazards to impel the FDA recently to confiscate some 1,000 cases of a no-phosphate detergent in New York and Maryland, while others have been ordered removed from the market.

Actually eutrophication in lakes and slow moving streams is primarily the result of overloading with carbonaceous detritus and, secondarily, with excess nitrate, both of which arise chiefly from municipal wastes, livestock feedlot and industrial effluents. Occasionally phosphates may be the limiting factor when their insertion into the waters will promote eutrophication, but such incidents are relatively rare and the contribution of detergent phosphates is essentially insignificant.

In any case even were it a factor, the solution to the problem is not to alternatively endanger the public through unnecessary exposure to caustic chemicals and reduced sanitation of their clothes, their culinary utensils and their domiciles, all of which are better cleaned and sanitized by conventional phosphate detergents than by the proposed substitutes.

The elimination of all phosphates whether detergent or those derived from human wastes, which incidentally constitute by far the greater amount, can be readily achieved from sewage effluents through appropriate processing in the municipal treatment plants with lime, or metallic salts (Al. Fe.). (Nesbitt 1971)

The excessive eutrophication in Lake Erie reported by Commoner (1966) to arise from detergent phosphates ignores the fact, remarked by Kumrei (1971), that "Lake Erie - thought to be only recently eutrophic - was found to contain flourishing algae blooms as early as 1928. This was 20 years prior to the advent of detergent phosphates, but the cities of Detroit, Windsor, Toledo and Chicago are old cities and their sewage effluent has been discharged into the Lake for years before 1928."

The phosphate components of farm applied fertilizers are also often accused in the public media for the occurrence of eutrophication, in lakes, ponds and slow streams. In contrast to the soluble nitrogens nitrate and ammonia, virtually no soil applied phosphate fertilizers reach open waters through percolation and subsequent surface seepage. Phosphorus is rapidly fixed by iron, aluminum, manganese and other cations in the surface and upper profiles of the soil and obdurately resists further vertical movement in solution. (Ponomareva et al 1968) (McAuliffe et al 1948)

Open water contamination with fertilizer phosphate is almost entirely due to surface runoff, while adsorbed to eroding soil particles. It is confined largely to topical applications that have not been incorporated into the depth of the surface horizon. In-soil hand-placement or tilled broadcast applications of phosphate fertilizers are seldom subject either to leaching or to wash-off. Only phosphate dressings made to a frozen or to a hard dry soil that becomes suddenly exposed to a heavy runoff such as a spring thaw or drenching rain before incorporation are likely to result in substantial movement of the phosphate into open waters. As these situations are rather rare in most farming practice, such phosphorus pollution can be considered negligible. (Wild 1950)

Biggar and Corey (1969) reviewing the effects of agricultural drainage on eutrophication, point out, however, that surface applied phosphate fertilizers rapidly saturate the fixing sites in the upper soil horizon and locally raise the concentration of phosphorus in the soil solution to an equilibrium status. This could reach one ppm in the soil solution depending upon the amount applied and the kind and form of the fixation sites, and in cases where runoff was prodigious could carry appreciable levels of phosphorus into moving streams.

Again, however, this is unusual and would be subject to considerable dilution and to further fixation of the phosphorus as it travelled the gathering muddy waters. Biggar and Corey (1969) speculate that "the contribution of eroded particulate matter to the nutrition of the algae may be associated more with its effects on the concentrations of soluble nitrogen and phosphorus in the incoming waters than with the total or 'extractable' nitrogen and phosphorus on the particles themselves." They also point out that Ca^{2+}, Mg^{2+}, K^+ and Na^+ cations are known essential nutrients for algal growth and may prove as important limiting factors in eutrophication as is phosphorus now claimed to be.

Thus Beeton (1965) studying eutrophication in the Great Lakes from Superior to Ontario reported that the major nutrient changes over the past 50 years, associated with eutrophication in Lakes Erie and Ontario are sulfate and chloride anions and calcium, sodium and potassium cations.

It would be instructive to determine what the present extensive use of calcium and sodium chlorides, applied for deicing roads, contributes to drainage water solutes and whether these constitute a significant factor in the eutrophication of the streams and lakes into which they drain. This would be of particular interest in the interior states where such effluents are far from ocean outfalls, and necessarily add to eutrophic factors in the fresh water lakes.

Provasoli (1958) noted that as the blue-green algae (Cyanophyceae) have an absolute need for both sodium and potassium cations, which is not the case for the other fresh water algae, the sudden occurrence of eutrophication in a body of water hitherto free might well arise from the intrusion of stimulative levels of sodium and potassium ions. Blue-green algal growth is regarded as an initial index of eutrophication and they often appear when the inorganic nitrogen level is exceedingly low and the soluble phosphorus virtually indetectable.

Sylvester (1961) examined the contribution of urban street and parking lot drainage to eutrophic contaminants following a heavy rainfall and noted that the total phosphorus contribution of each was approximately the same (208 vs 251 ppb), although the soluble phosphate from agricultural drainage was from two to two-and-one-half times higher (i.e. 162 vs 76 ppb). Organic nitrogen on the other hand was an order of magnitude higher from urban wash-off (2010 vs 205 ppb) while the soluble nitrogen was two to five times higher from agricultural drainage (2690 vs 527 ppb). This reflects the high levels of organic detritus in our city streets. Weibel et al (1964) observed similar wash-off levels of phosphorus and nitrogen from urban streets near Cincinnati, Ohio. With a population concentration of 9/A both phosphorus and nitrogen street wash-off per annum was approximately 1/10 of the sewage source: 2.5 lbs. P_2O_5/A/yr. + 8.9 lbs. N/A/yr. from urban wash-off compared to 27 lbs. P_2O_5+ 81 lbs. N/A/yr.

In general it can be concluded that although in specific instances phosphate induced eutrophication does indeed occur, its sources are usually multiple and common to other eutrophying factors, and that it cannot be regarded as either the single or the major cause.

Furthermore, as phosphorus is an essential nutrient for all living cells, and, in the forms normally found in the environment is entirely non-toxic, it cannot be regarded as a serious ecological hazard. As the major eutrophic factor in lakes and streams appears to be primarily domestic sewage effluents, the phosphate problem can be readily resolved by its removal at the sewage treatment plant through simple precipitation.

As a result of the inordinate pressures to reduce phosphates in detergents, it seems probable this will become politically expedient to legislate into oblivion; however, the suggestion that fertilizer phosphates should be curbed will predictably get nowhere, for their absence from the farm scene would lead to substantially reduced yields and quality of foods and a proportionately greater increase in the retail cost of food and fiber. This would readily be unrecognized as politically inexpedient, and therefore totally unacceptable. Phosphatic-like nitrogenous fertilizers will therefore remain in the environment.

PESTICIDES

Economic Considerations

The intensification and concentration of crop and livestock production into a virtual monoculture in many farming areas has become an economic necessity but it invites pests and parasites of these domestic species also to congregate. This inevitably occurs and no amount of productive efficiency or reliance upon natural controls has, as yet, provided a margin of protection sufficient to maintain economic yields or the required quality of produce.

Neither is there, at the present state of the art, any reasonable probability that adequate suppression of even the key pests, on all crops and all livestock, can be achieved by biological or natural control measures.

Irving (1970) remarked that of the 10,000 reported pests that plague man and his domesticated crops and animals of which at least 3,000 are recognized as major pests, there are not more than 100 which are subject to significant biological control and of these not more than 30 of any real economic and practical importance. There is actually not one single economic crop, plant or livestock species which can be presently produced economically to meet the quality standards demanded by the consumer and generally required by law and be solely protected by biological controls. Although biological controls are being developed, and a few have accomplished brilliant success, for the grower the best that can be anticipated is an enlargement of integrated programs involving sophisticated and often quite complicated combinations of chemical and biological controls.

For even with elaborate chemical controls in the U. S., insects, disease and vermin still take a toll of some $20 billion annually or roughly 25¢ per consumer food dollar. Without such chemical controls food and fiber yields would drop at least 50% and costs rise perhaps 4-5 fold for inferior produce quite unacceptable to the American housewife. In India, for example, over 50% of the already impoverished harvests never reach the consumer due to the ravage of pests, in a country where upwards of 300 million people are continuously on the verge of starvation. Certainly among these emerging peoples providing them with improved genetic stocks, fertilizers and farm machinery will be quite futile if insects, disease and weeds consume the increments.

Public Health and Pesticides

Apart from the effect on public health of an abundant food supply free from the blemish of insects or disease, the control of arthropod borne human and livestock diseases by pesticides, particularly the organo chlorines, constitutes the most remarkable accomplishment in public health medicine. DDT, for example, has saved more human lives than all the wonder drugs.

The WHO campaign to reduce malaria, the greatest disease killer and debilitator of mankind for millenia, achieved singular success in India and Ceylon, among many other countries. Using DDT primarily as a spray in domiciles, malaria in India was reduced over 75 million cases per year to less than five million within ten years and has now been further reduced below one million cases per annum. (Jukes 1963) (N.C.D.C. 1969) The result has been a substantial rise in the productivity and vitality of the entire nation.

Similar results were also achieved in Ceylon, an island of ten million population the size of West Virginia, where malaria had infected 20% of the people annually. After three years the WHO anti-malaria program using DDT virtually eradicated the disease. From 1950 to 1964 there were less than 100 cases per year, most of which were imported from the mainland. In 1963 the use of DDT was banned in Ceylon for political and clearly unsound reasons. Gradually at first but with accelerating momentum, the Anopheline mosquito vector returned and with it the blood parasite. By 1968 some half million people were infected and by 1970 the disease was approaching two million cases. (N.C.D.C. 1968) The Singhalese Government has wisely returned to the use of DDT in domiciles and their environs.

It is a matter of considerable public health concern that a number of Anopheline spp which vector malaria are currently increasing along the Atlantic, Gulf and California coasts, for when combined with widespread reservoirs of contagion among the returning veterans from Indo-China, the elements for an epidemic of malaria are nascent.

It would certainly be most unfortunate if not rather mortifying if, after going out all over the world to eradicate this dread disease among a billion people, we allow it to recur in epidemic proportions in our own back yard.

There are, in addition to malaria, some fifteen other major arthropod-borne diseases of man and a like number of livestock. In all these cases eradication of the vector is the most effective, if not the only way, to control the spread of the disease. For many of these diseases there are no cures, only symptomatic treatment and fervent hope not generally regarded as particularly effective in medical circles. The encephalitides, for example, are mosquito vectored, are thoroughly sequestered among wild and domestic animals that tolerate them, are largely both incurable and unpreventable except by reduction of the vector. Prophylactic vaccines for humans were at one time being developed but were abandoned. The encephalitides are enormously injurious to many forms of wildlife. Birds, particularly sport birds such as pheasants and quail, are very susceptible and perish. The disastrous effect of Venezuelan Equine Encephalomyelitis (VEE) on horses and other equines has recently been well publicized as a result of the migration of this disease up the Central American isthmus, across Mexico into Texas. Unfortunately the only effective measure to stop its spread, aerial spraying of the mosquito vector's breeding haunts with a persistent pesticide, was commenced too late, and with a compound too ephemeral to really block its advance. Vaccination of potentially exposable equines is effective, for domestic animals, but should the vector and its disease spread into the Rocky Mountains the few remaining mustangs and other wild equines stand helpless and naked to exposure and in deadly peril of being totally extirpated.

Here then an ecological judgement must be made between sacrifice of some fish, crustacea, molluscs, plus perhaps a few shore birds, all of which would be rapidly replaced as against the certain loss of considerable numbers of domestic and wild equines, together with sickness and some deaths among humans. Perhaps an operations research mathematical systems model can be designed to compute how many humans or horses are ecologically worth one fiddler crab or a clam.

Forest Ecological Considerations

It has been repeatedly asserted that control by aerial sprays such as DDT, carbaryl malathion, etc., over forest lands invaded with an epizootic of defoliating insects, such as Gypsy Moth (*Porthetria dispar*), Hemlock Looper (*Lambdina fiscellaria*) or the Western Spruce Budworm (*Choristoneura occidentalis*) induces such profound ecological disturbances among the natural parasites and predators that control of the pest is ephemeral while the concomitant injury to wildlife is both prolonged and severe.

These thinly supported though widespread assertions have led to such public clamor that in many areas where woodland and forest defoliators are rampant, effective spray controls have been withheld or replaced with, at best, partially effective substitute controls. Even in cases of massive epizootics, such as the current Gypsy Moth attack in the southern New England and Mid-Atlantic states (Goodman 1971) or the Hemlock Looper infestation in the northwestern mountains, effective controls have been withheld as a result of these misinformed public pressures. The total ecological impact of these massive forest defoliations has never been fully assessed and, consequently, evidence of their total and long term effect upon wildlife is equivocal.

The socio-economic effect on recreation and lumber supplies is, however, well recognized. (Nichols 1961) Where successive defoliation occurs, over a two or three year period, as in the case of Gypsy Moth, the death of canopy and viable plant roots exposes the soil to erosion at least until ground cover is again restored. The deprivation of the wildlife from their essential feeding, nesting and breeding facilities is obvious.

The question therefore is what are the relative magnitudes of the insults to the total environment induced by defoliation of say a million acres of hardwood forest with virtually total loss of 10% or 100,000 acres as compared to the environmental injury induced by the aerial spraying of three quarters to one pound of DDT per acre or some similarly effective pesticide? Is there really such a significant permanent impairment of the forest ecology from such a spray program, one that even remotely compares to the inordinate ecological disruption of an extended Gypsy Moth or Spruce Budworm epizootic?

There are, obviously, much data to be yet assembled, but recently Carolin and Coulter (1971) presented cogent evidence on the chemical control of Western Spruce Budworm attacking the Douglas and grand fir (Pseudotsuga menziesii and Abies grandis) forests of the Cascade Mountains of Oregon and Washington. Minor spot infestations occurred up to 1946 when the pest exploded into an extensive epizootic of close to one million acres in 1947 (Whiteside 1955). Large scale aerial applications of one pound DDT in one gallon fuel oil/A, were made over a total of nearly four million acres between 1948 and 1955 where epizootics occurred (Whiteside 1958). No spraying was required for the two following years. In 1958 some 800,000 acres were again sprayed in northwest Oregon and about 45,000 acres in 1962 in the eastern Cascades in Washington, two isolated areas where the pest reached threshhold levels. In the intervening decade budworm populations have remained well below the threshhold, although the pest was present.

Evidently the predatory control was not impaired by the spraying, and careful monitoring revealed that by two years, after spraying ceased, parasitism of the Tortricid larvae was at the same level as that noted prior to the spray program. Furthermore it was observed that at the insecticide dose applied, hymenopterous parasites of the Spruce Budworm survived and proliferated more effectively than did the dipterous parasites. There was also an increased incidence of parasitism in the sprayed areas compared to the unsprayed sections.

Macdonald (1959) also reported increased parasitism by Apanteles and Glypta of Spruce Budworm larvae in New Brunswick, Canada, following spraying than that observed in check areas. Nichols (1961) reviewed the program which eradicated the Gypsy Moth from Pennsylvania, and reported that extensive spraying of the Alleghany Mountains with 0.75 to 1.0 lbs. of DDT in oil/A elicited no untoward effect upon either avian or mammalian wildlife, which conversely flourished as a result of the protection of their feeding, breeding and nesting haunts.

Keith and Hunt (1963) in a replicated trial with aerially applied malathion against the Lodge Pole Pine Needle Miner in the Yosemite Mountains where the treated and check blocks aggregated several thousand acres each, reported insignificant differences in both avian and mammalian wildlife between the sprayed and check blocks immediately prior to, and 96 hours, 30 days, and one year after treatment. If any difference occurred it suggested higher populations of birds a year later within the sprayed areas.

Strickler and Edgerton (1970) monitored the fate of a DDT aerial spray at 0.75 lbs. active ingredient/A to control an epizootic of tussock moth (Hemerocampa pseudotsugata) on Douglas fir and Ponderosa pine in Oregon. As the understory vegetation was usually grazed by livestock, elk and deer they particularly followed the DDT residues on sedge, lupine and sagebrush in the understory. Up to 80% of the applied active compound reached the ground vegetation, depending upon exposure. Within four months after the spray application the DDT residue had dropped to from 10 to 18% of the immediate post spray level and by twelve months it had declined to pre-spray levels. They found no evidence of recycling, suggesting the decay rate was actually due to chemical degradation. Coincident monitoring assays of DDT in the adipose tissue of livestock and wildlife grazing the treated vegetation revealed a rise and decline comparable to that noted on the vegetation, i.e. there was no prolonged accumulation. (Crouch and Perkins 1968)

Admittedly when a large area of forest is aerially sprayed with a broad spectrum pesticide, the only practicable method, some loss of beneficial and innocent species is likely to occur - e.g. fish, zooplankton and predatory arthropods, but the decision has to be made in a calculated trade-off whether to save the forest as a source of lumber, of recreation and of sustained wildlife (Haeussler 1952) or the loss of a few minor species which generally recover rapidly anyway and which would undoubtedly also suffer a serious decline if the forest were to be reduced to desolation by the pest epizootic. Obviously the total forest ecology is better sustained by the carefully timed and metered spraying of an effective, safe pesticide than it is by relying upon the so-called "balance of nature" which might not permit the return of the original pristine environment for perhaps a century or more. When it is also considered that insects and their disease sequalae annually destroy more than tenfold the lumber of all the forest fires combined, it really should not be particularly hard to make the decision. (Haeussler 1952)

The recent relaxation in the chemical control of the Gypsy Moth in the northeastern states, has allowed this voracious polyphytophagous pest to extend itslef throughout the eleven northeastern states at endemic levels which during the past five years have become epizootic in Connecticut, New York, Pennsylvania and New Jersey.

At least one million acres are heavily infested and the pest is reaching down into the Blue Ridge Mountains of Virginia, and has leapfrogged (presumably through egg masses deposited on trucks, trailers, etc.) into several southern and midwestern states and across the Rockies and High Sierras Mountains into California. Should this pest not be eradicated from these new seedings, and substantially rolled back in the northeast, its environmental impact will constitute an ecological disaster of major proportions. (Goodman 1971)

By 1962 the Gypsy Moth had been driven behind the eastern slopes of the Green Mountains of Vermont and, within a few more years of the eradication program, might well have been extirpated from the eastern states. (Nichols 1961) The program was, however, withdrawn or reduced in the early '60's to what now appears to be obviously an inadequate level, largely as a result of the mass public hysteria arrayed against it.

It seems improbable that this noisome forest pest will be effectively checked before it has seriously impaired the ecology of much of our forest lands. Hopefully the combination of sex lure hormone-like compounds, (Gyplure, Disparlure), male sterile treatments released predators and parasites and a more general and effective pesticidal control program, will, at least, reduce its spread. (Jacobson 1965) (Knipling 1969)

It is the general consensus of experienced forest entomologists and wildlife conservationists that man-made incursions, that disturb the forest ecology, should be minimized consistent with the use of the forest for lumber and recreation; but when an ecological disaster approaches, be it a fire from lightning or the devastation of a pest, sensible, practicable and effective measures must be taken to reduce or turn back the environmental insult. Such measures may well constitute an ecological insult themselves as in the case of a backfire but the long-term effect is one of ecological benefit to the forest environment as a whole. The decisions to spray, where, when, how, with what and how often must be made in each individual situation by a concordance of qualified specialists in the disciplines involved.

The use of herbicides in forest management has also recently been seriously criticized and condemned. It is, however, an essential tool in the maintenance of stream banks and utility rights-of-way. Even where riparian rights exceed those of timber production and recreation, it has been shown that discriminate control of wild brush enhances the water economy. (Pierce 1967) (Reigner et al 1968)

Extensive studies of "before" and "after" herbicidal sprays to control undesirable underbrush, stream clogging weed growth and right-of-way clearance revealed no injurious effects on the environment and no significant contamination of drainage waters. Herbicides investigated include AMMATE, 2,4-D, 2-4-5 T and Silvex. (Reinhart 1965; Drammes et al 1964; Reigner et al 1964; Paine 1959; Winston et al 1961; Anon. USDA 1961). Degradation of commonly applied herbicides in forest and wildlife management (2,4-D, 2,4,5 T; a mitrole, silvex; picloram) is both rapid, up to 90% in four months, and is unaffected by coincident applications of DDT, phosphamidan or carbaryl for insect control. (House et al 1967; Norris 1966, 1967a, 1967b, 1970)

Contamination of Waters

Because pesticides may enter running waters through leaching, sewage and industrial effluents, soil erosion or direct application, it is felt they can travel great distances and extend their damage into remote and unintended "eco-systems". This is to some extent true, but three often ignored mitigating factors are: first, the tremendous dilution which occurs as the compound courses the gathering waters (Lamar 1965); second, the most persistent pesticides are exceedingly insoluble in water, while the soluble ones degrade rapidly; and, third, even the most persistent pesticides, such as DDT, aldrin, toxaphene, etc., do eventually degrade either chemically or biologically, into less toxic compounds. - Lichtenstein (1965-66); Gish (1970)

The argument raised to negate the dilution factor is that the phyto and zooplankton of open water rapidly reconcentrate the pesticide from the dilute ambient solution and successively accumulate it up the food chain until it becomes acutely or at least chronically toxic to vertebrates, chiefly fish and birds at the top of the chain. Equipped with fantastically sensitive analytical instruments, multiple pooling of organo chlorine insecticides among certain aquatic species has been demonstrated. (Vance et al 1969; Sweeney 1968; Brocksen et al 1967; Crosby et al 1968) Thus, under laboratory conditions, blue-green algae pooled dieldrin 180 X, DDT 268 X, aldrin 225 X, and endrin 222 X of the ambient concentrations while green-algae showed corresponding increases of 127 X, 270 X, 143 X and 156 X respectively, when the ambient level was several orders of magnitude above saturation. Obviously such magnification is due to adsorption rather than absorption. When true ambient concentrations are actually in the 10 to 100 ppt range such magnifications are in fact negligible. (Lamar 1965)

As the level to which a compound will accumulate in any given species, aquatic or terrestial, is directly related to the dose, it follows that the degree of magnification becomes a function of the initial environmental exposure level. (Robinson et al 1967; Hayes 1959; Chadwick 1969) Thus laboratory experiments that induce excessive pick-up of persistent pesticides by aquatic organisms by bathing the test species in supersaturated suspensions are not particularly indicative of what really occurs in the environment.

Brockson et al (1967) examined the magnification of DDT and its metabolites in the food chain of Rattlesnake Creek, a drainage channel in the Ochoco Mountains of Malheur National Forest, Idaho, prior to and following the aerial application of one pound of DDT (active)/A to control Douglas-fir tussock moth. He followed the DDT as it occurred 30 days, 90 days, eight months and 12 months post application in the ambient water at less than one ppb through algae (87 ppb), herbivorous insects (770 ppb), carnivorous insects (320 ppb), dace (1,015 ppb) to trout (1197 ppb) at the top of the chain. This constitutes a total maximum magnification of about 10^3, which is, of course, substantial, but hardly disastrous, as the nominal level of these compounds in waters draining treated areas lies from one to 100 ppt. The levels given were the maxima observed in each species and occurred from 30 to 90 days post application, declining rapidly thereafter.

Chadwick (1969) reported that sculpins held in controlled laboratory streams with 0.5 ppb of dieldrin and fed midge larvae with and without dieldrin accumulated the pesticide to the steady state level at essentially the same rates. It was concluded that the only 15% of the total dieldrin accumulated was contributed by the food source. If this is found to be the case with other species, then, at least among aquatics, food chain magnification is of relatively little importance.

Certainly the annual reports of the unnatural fish kill in the U. S. (formerly published by USDHEW-PHS and recently by USDI-FWPCA) have indicated for several years now that the annual fish mortality due to all agricultural chemicals combined is less than 3% of the total while industrial and municipal effluents account for over 75%.

Ecologically, however, there can be no doubt that sublethal levels of pesticides exert a selective genetic effect upon both fish and amphibians which will ultimately be reflected in their evolution. (Ferguson 1969) Whether this constitutes a detriment or a benefit to the environment is, as yet, undetermined, but it would seem likely, in the light of the law of natural selection, to be a benefit as the converse would tend to eliminate the species.

Terrestial Wildlife Considerations

The public concern over the impact of pesticides upon terrestial wildlife, particularly birds, is not entirely void of justification, but it has been exaggerated out of all proportion to the facts. (Mellanby 1967; Edwards 1970)

There is actually no valid evidence, despite the vibrant assertions in the press, that any registered pesticide when applied in accord with Federally approved recommendations has ever invoked massive irreversible bird kills of any species. Even where incorrect and illegal applications have been made or irresponsible dumping of pesticides have been found to injure and destroy wildlife, such kills are insignificant when compared to the inordinate losses of wildlife induced by the natural hazards of winter wastage, storms, starvation and disease, (often arthropod vectored disease), and such man-made hazards as skyscrapers, TV towers and traffic.

Wildlife census conducted by the USDI-Fish and Wildlife together with those made by private organizations reveal beyond question that most of the favored species, both mammals and birds alike, have actually proliferated to levels considerably above those noted before the modern organic pesticides were introduced.

Whether DDT and related organo chlorines interfere with avian reproduction under exposures normally found in the field is still open to debate, and will not be satisfactorily resolved until more data is accumulated. Certainly there could hardly be a bird population explosion in the face of a serious impediment to reproduction.

CONCLUSION

Agricultural chemicals are and will continue to be an essential tool in meeting the food, fiber, shelter and recreational needs of the people.

It would be quite impossible to feed and clothe the present human population, let alone that of seven billion, thirty years from now without the continued use of fertilizers and feed supplements, or pesticides and medicaments.

As crop and livestock production intensifies under the rising pressures of demand, it will be essential to monitor the ecological impact of these chemicals on the environment and derive use methods which will minimize their effects. This, however, will not require their abandonment.

Present claims of alleged injury to the environment by nitrogenous and phosphatic fertilizers and pesticides, even the more persistent types, have been grossly exaggerated.

In many cases it can be shown that agricultural chemicals actually improve rather than desecrate the environment.

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with compliments;
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"DDT, HUMAN HEALTH AND THE ENVIRONMENT"

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DDT, HUMAN HEALTH AND THE ENVIRONMENT

By Thomas H. Jukes[*]

For the past two years there has been an intensive campaign to ban the insecticide DDT (dichlorodiphenyltrichloroethane) from use in, manufacture in, and export from the United States. This article evaluates the evidence for some of the charges in this campaign. These include charges that DDT is a "biocide" (a name implying that it is poisonous to all forms of life), permeates the environment, is virtually indestructible, kills many desirable forms of wildlife, and is dangerous to human beings. The last of these claims is particularly astonishing in view of the fact that DDT has saved millions of human lives from malaria, typhus fever, plague and other deadly diseases without harming a single person, except in a few cases of accidental or suicidal overdosage.

The propaganda against DDT has been so extensive and successful that DDT is now widely regarded by the public as a dangerous poison. There have been a series of newspaper cartoons, skillfully staged television shows, and a display of bumper stickers with skull and cross-bones, all aimed at exposing the evils of DDT. The National Audubon Society printed 700,000 copies of a leaflet urging that the export of DDT be stopped. This leaflet was distributed at about the same time a resolution requesting the continuation of the use of DDT was passed at a meeting of the WHO Regional Committee for Southeast Asia held in 1969 in Nepal, attended by representatives of eleven tropical countries totaling over 700 million in population—about 1000 people for each Audubon leaflet.

Many people have become self-constituted authorities on DDT as a result of exposure to mass media. For example, the chief judge of the Circuit Court of Appeals in Washington, D.C., announced in January, 1971, that DDT kills honeybees and is dangerous to people. Yet, while other insecticides, such as parathion and Sevin, do kill bees, DDT's effect on these insects is only minimal. As regards DDT's effects on people, the principal consequence has been to increase population, not endanger lives.

What are the facts of this strange paradox? What motivates those who crusade against the most useful chemical in history? Is the attack on DDT partly directed against its role in accelerating the population explosion?

The organizations that are most active in the movement to ban DDT include some of the large conservation groups. Despite the size of some of these groups, they do not speak for all segments of the population. Some environmental groups, in fact, have recently been challenged by organizations which represent racial minorities. As the following statement suggests, the needs of the urban poor are not likely to be assuaged by the Thoreau-like preoccupations of many of the conservation associations:

> In general, black people probably do not know much about the science of ecology or the study of human conservation as now offered in most universities. Probably they know very little about bay fill, polluted streams, soil erosion or redwood trees. And probably they couldn't care less. But precisely because they are black and poor, they do know a great deal about 125th Street in New York, about South Street in Philadelphia and the Fillmore in San Francisco. About those environmental disasters they are very knowledgeable and they can also tell you quite a bit about human conservation as practiced on any of those nearby street corners, in the filthy two-, three-room walk-ups, in the fetid housing projects or in their urine-, vomit-, whiskey-, blood-stained hallways which exist all over, everywhere, in the uninhabitable cities of America's enraged and inconsolable slum communities.[1]

The National Audubon Society, which appears to have a predominantly white and middle-class membership, is one of the most active anti-DDT organizations. For a member to condone the use of pesticides would be tantamount to the deepest heresy in a religious sect. For an official of the Society to approve such use would be fiscal lunacy, in view of the tremendous amount of free publicity that the Society has received as a result of *Silent Spring*[2] and other publications which have established a new mythology—the extermination of wild birds by agricultural pesticides. The Society shows underlying resentment of human beings and all their works, including cities, farms, highways, and especially private industry. Membership in the Society is a form of expiation of the sin of being one of the human race, the species that consumes "the environment". The Society stated recently that one of its two main purposes is "the education of man regarding his relationship with and his place within the natural environment as an ecological system."[3] This pious pronouncement is actually intended to exclude man as an inhabitant of the Earth, except in small numbers and in a primitive, mythical, aboriginal state. The Audubon Society has no program for the relief of suffering among millions of human beings in the tropics.

Two other organizations that have attacked DDT are the National Geographic Society[4] and the Sierra Club. The National Geographic Magazine advertises plush overseas tours for the wealthy people. The magazine has beautiful photographs of wild animals, birds, and under-dressed natives in picturesque attitudes. These pictures do not show the ravages of tropical diseases that can be controlled by DDT. The Sierra Club, which is seeking legal action to obtain a ban on DDT,[5] also features expensive outings to remote lands, again largely for the healthy and economically secure. The motivation of conservation organizations is primarily to protect the landscape and its wildlife. This may be in conflict with combatting hunger and disease in human beings.

Why is it necessary to defend DDT? Why can't other insecticides be used instead? The answer is that DDT is specifically needed to protect millions of people in tropical countries from death by malaria. This has repeatedly been made plain by the World Health Organization in statements such as the following:

> The withdrawal of DDT would mean the interruption of most malaria programs throughout the world. . . . DDT used as a residual spray of the interior surface of houses. . . led to the idea of nationwide malaria control campaigns including the whole of the rural areas of a country. The success of these campaigns resulted in the concept of malaria eradication which was adopted. . . for the world by the Eighth World Health Assembly in May, 1955.
>
> Since then DDT has been the main weapon in the world-wide malaria eradication program. Research has continued for the development of other methods of attack against malaria and for the development of alternative insecticides. To date, there is no insecticide that could effectively replace DDT which would permit the continu-

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> ation of the eradication program or maintain the conquests made so far.
>
> The withdrawal of DDT will therefore represent a regression to a malaria situation similar to that in 1945. The reestablishment of malaria endemicity would be probably attained following a period of large-scale outbreaks and epidemics which would be accompanied by high morbidity and mortality due to loss of immunity by population previously protected by eradication programs.
>
> Toxicological observation of spraymen working for a number of years in malaria eradication, and even in formulation plants, has not revealed toxic manifestations in them or in people residing in houses that have been repeatedly sprayed at six month intervals.
>
> We therefore believe that a great harm will result from the unqualified withdrawal of DDT. We feel that selective use of DDT is justified and warranted.[6]

This is what the argument is all about. If the manufacture and export of DDT are banned in the United States, the world-wide antimalarial program will collapse. Most of the DDT manufactured in the United States is for this program. Furthermore, a ban in the United States would lead to prejudice against the use of DDT elsewhere.

Those who are fighting the ban are struggling to save lives. The objective is not to "protect the chemical industry," since the substitute insecticides are more expensive and more profitable than DDT. These substitutes can be used, with varying degrees of lower efficiency, against the agricultural pests that are controlled by DDT. But there is no effective substitute for DDT in the world-wide campaign against malaria. The other compounds either decompose rapidly, produce resistance too fast, or they are too poisonous to people.

TOXICOLOGY

There is a saying among toxicologists that this subject can be easily learned in two lessons—each five years long.

One of the oldest principles in toxicology was stated by Paracelsus almost 500 years ago: "Everything is poisonous, yet nothing is poisonous." This is quite familiar to biochemists, who recognize that several chemical elements commonly regarded as poisonous are essential in small amounts to life. Examples of these are copper, chromium, manganese and selenium. The last named of these is also carcinogenic (*i.e.*, tends to produce cancer). Traces of practically all the elements can be detected by spectroscopic tests in most biological materials, and all living creatures contain radioactive carbon and radioactive potassium. The crucial matter is the quantity of such substances that we consume in proportion to the amount that is toxic. It is comparatively easy to poison animals with table salt in high dosage.

The development of modern analytical methods of sensitivity has enabled many substances to be detected in concentrations of less than one part per billion (ppb). If the substance thus detected is commonly regarded as a poison, then the detection of such traces in unexpected places may cause public alarm, especially when the news is presented in a sensational manner. The claimed detection of DDT in Antarctic penguins at levels in the range of one part per billion has been used to imply that the whole world has been poisoned. The finding actually shows that molecules can be dispersed widely, and that the analytical device known as vapor phase chromatography, or electron capture, is extraordinarily sensitive. Such procedures can easily give erroneous results if substances are present which simulate the compound whose measurement is sought. The analysis must be carried out by an expert, or better, by two or three experts working independently, if reliable results are to be obtained.

Another basic concept of toxicology was stated by Lucretius two thousand years ago: "Quod cibus est aliis; aliis est acre venenum"—"One man's meat is another man's poison." The scientific application of this proverb is known as comparative toxicity; it is a keystone of therapeutic medicine. A significant goal of researchers in the area is easily understood in terms of the metaphor of the "magic bullet."[7] Drug therapists have continually searched for chemical "magic bullets" which hit disease carriers while missing patients. DDT is such a "magic bullet" because it kills mosquitoes and other insects that carry disease, but does not injure human beings. The idea of the "magic bullet" is more precisely expressed by the therapeutic ratio, which is the fraction of the minimum lethal dose of a drug that is therapeutically effective. The smaller the fraction, the safer the compound is for general use.

Research in comparative toxicity has led to the discovery and development of chemicals, such as antibiotics and pesticides, which enable the human species to compete successfully with other forms of life, especially disease organisms. Although it is

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possible that advances in comparative toxicity will contribute to a serious overpopulation in man, it is *certain* that inattention to this field of knowledge will permit a critical fall in global food supplies and global public health.

Malaria

From time immemorial human beings have been hosts to a genus of protozoa known as *Plasmodia.* There are many species in this genus; three of the principal ones that attack human beings are *Plasmodium vivax*, *P. malariae*, and *P. falciparum.* They produce respectively three different types of malaria. Of these, the most malignant is that produced by the *falciparum* species, which often attacks the brain. These three Plasmodia spend part of their life cycle in mosquitoes, but the cycle is not complete without going through several stages in man, where they reach maturity in the red blood cells and reproduce, in enormous numbers, into a form called *merozoites*. These change into the sexual stage, which enters the body of a blood-sucking mosquito. Other stages of the life cycle then take place, and the parasite reaches the salivary gland of the mosquito, from which it is inoculated into the next victim bitten by this insect. The cycle then continues from man to mosquito, and mosquito to man. The principal method for breaking this pernicious chain is to kill mosquitoes with DDT by spraying the interior walls of human dwellings.

Public health authorities in the tropics apparently use a figure of 1 per cent per year to estimate the mortality from malaria; thus 75 million cases in India in one year were calculated to be responsible for 750,000 deaths.[8] The survivors in many cases are severely debilitated and unable to work.

The mosquitoes rest on the walls by day and attack sleeping people at night. If DDT is sprayed on the walls, it kills the mosquitoes. An insecticide for this purpose must be *persistent* because it is not possible for spray teams to go into the same house frequently. Malathion, for example, is non-persistent and soon decomposes; it also has a pronounced and offensive odor. The procedure must be *safe* to those dwelling in the house, and to the sprayers, who are intensively exposed to the insecticide. The development of resistance by mosquitoes to the insecticide must be slow enough to enable the life cycle of the mosquito to be broken. DDT as opposed to lindane, for example, fulfills this requirement. Note that the WHO program favors spraying walls to kill adult mosquitoes rather than spraying ponds and swamps to kill larvae.

I have not mentioned cost, because this should not be a prime consideration when many human lives are at stake. However, Russell estimates that the appropriations of the United States for overseas malaria control and eradication amounted to a half-billion dollars in the past 25 years.[9] As a result of international cooperation, WHO has maintained an effective world-wide malaria eradication program:

> Today more than 960 million people who a few years ago were subject to malaria endemicity are now free of malaria; another 288 million live in areas where the disease is being vigorously attacked and transmission is coming to an end. Because much of Africa remains highly malarious and because about 288 million people live in malarious areas not yet subject to eradication measures, it is logical that the United States should maintain an active interest in this disease.[10]

These estimates by Dr. Russell indicate that the United States contribution to saving lives from malaria has paid off quite well in terms of human welfare. As I said recently however, "some Americans, by demanding a ban on DDT, are reversing the traditional role of their country in relieving the sufferings of others."[11]

DDT in Agriculture

Insects compete with mankind for food. They devour all parts of plants—leaves, stems, fruits and seeds. A plant attacked by insects will often die without producing seeds or fruit. The vulnerability of plants to attack by insects is greatly increased by agriculture, which inevitably leads to what is called "monoculture"—the growing of a single crop in a large area of land, such as a field. Obviously a group of crop plants, such as potatoes, corn, tomatoes and alfalfa, cannot be grown as a mixture. Food must be grown on farms using monoculture, unless and until some other method of providing nourishment is developed.

Prior to World War II methods of controlling agricultural pest insects included the use of "stomach poisons", the most effective of which was lead arsenate; the use of contact poisons, *e.g.*, nicotine sulfate; and the use of hand labor, *e.g.*, for burning cornstalks and plowing them underground in the fall to control the European corn borer, or for picking bugs off potato plants. The discovery of DDT revolutionized the control of agricultural insects. It also replaced lead arsenate, which is virtually indestructible, and highly toxic.

DDT is intensely poisonous for many insects, and is less toxic for plants and warm-blooded animals. Like all chemicals, however, DDT has a level of toxicity for any species of animal or plant. The extensive use of DDT, without adequate controls, has resulted in the killing of non-target species. In some instances this was an accepted risk. For example, when forests were sprayed to control the spruce budworm, many fish were killed in the streams. These were replaced by planting other fish.

DDT is poisonous to crustacea, such as crabs. Careless use of DDT and other pesticides that results in their drainage into rivers, swamps, lakes, estuaries and coastal waters must not be allowed. This precaution would remove a major source of friction between agriculture and those who are interested in wildlife. Actually, a rapid reduction is currently taking place in the agricultural use of DDT, and this will undoubtedly lead to a lessening of its movement through "food chains," which concentrate fat-soluble substances. However, if DDT suddenly disappeared this would not end the problem. Most of the fish that are killed by pollutants in inland waters are the victims of petroleum wastes, industrial wastes and sewage, just as most eagles found dead are killed by gunfire. The role of other pollutants is just beginning to emerge.

Solubility in fats is not an exclusive property of DDT or of the other pesticides that are similar to it. Recently it has been found that mercury can be converted into a fat-soluble form, methyl mercury, by bacteria. This form can enter food chains and, by stepwise concentration, produce effects that are toxic to animals and birds that eat fish. Mercury has been present in sea water ever since the oceans were formed, and occurs in the earth's crust. It does not become a problem until its concentration is greater than the toxic level. This level can result from industrial contamination, but the possibility exists that such levels also occur under natural conditions.

Space does not permit an adequate discussion of the vast topic of the effect of chemicals on wildlife. Many of the conclusions are based on inferences, rather than on controlled experiments. There arise therefore ambiguities, which lead in turn to disputes. The final answer may differ from the first guess. It is thus best to react cautiously to preliminary judgments regarding the death or disappearance of wildlife. For example, a few winters ago robins were unusually scarce in the coastal cities of California and DDT was blamed widely. The robins were actually back in the mountains, feeding on an unusually fine crop of berries, and the following winter they were in town as usual.

How to Alarm the Public—A Study in "Eco-Tactics"

A syndicated newspaper article has described the history and activities of the Environmental Defense Fund (EDF), asserting that the EDF "has swiftly become the public defender of the environmental movement." The article stated that

> The turning point came when Cameron decided to spend about $5,000 of the organization's total remaining assets of $23,000 on an advertisement in the New York Times on Sunday, March 29, headlined 'Is Mother's Milk Fit for Human Consumption?' It referred to the amounts of DDT in the human body.
>
> The ad appealed for members, starting at $10 for a basic membership. It produced $7,000, a profit, and the EDF turned to a direct mail campaign and now has 10,000 members, a stable financial base and a chance at major foundation support.[12]

This is a most interesting revelation. The EDF appealed to the public on the basis of the DDT content of human milk. As a means of arousing alarm concerning DDT, the EDF and the National Audubon Society have both stated that DDT causes cancer. The implication that DDT in breast milk may cause cancer in babies is superlatively sensational copy. The following lurid passage is from an article by Ed Chaney, Information Director, National Wildlife Federation:

> A five-day-old human being lies asleep in the other room. His name is Eric. His tiny, wiggly, red body contains DDT passed on to him from his mother's placenta. And every time he sucks the swollen breasts, he gets more DDT than is allowed in cow's milk at the supermarket. Be objective? Forget it. Objective is for fence posts. How can you be objective in the face of a global insanity that is DDT? In the face of abdicated responsibility by the men the public pays to protect its interests. Are the anarchists right? Are ashes the only fertile seed bed for growing new responsiveness to the public interest? Picture a swarm of angry citizens bathed in the light of flames engulfing the Agriculture Department.[13]

It is distressing that an official of a large organization should discard objectivity and propose anarchy in its stead.

Let us examine the factual and scientific background for the propaganda campaign regarding DDT in human milk. The background starts with the improvements in technology that made it possible to detect fantastically small quantities of DDT. Note that such extremely delicate tests can easily give "false positive" readings because of accidental contamination of the equipment or lack of expertise by the tester. We must next note that cows' milk has occupied an unusual position among foods with respect to regulations. "Zero tolerance" has been the policy with respect to additives to milk, except for vitamin D. The improvements in testing procedures made it necessary to re-examine the definition of zero, since every chemist knows that zero content, in molecular terms, does not exist. For example, all fish and all human beings have contained mercury for millions of years (*i.e.*, before the chemical industry existed). To get back to milk, more than ten years ago it was evident that the entire canned milk stocks of the United States contained DDT. It was therefore necessary to face facts and choose one of two alternatives: ban cows' milk from interstate commerce, or set a tolerance.

The second alternative was chosen, and the tolerance set at 0.05 parts per million (ppm). This was a far lower level than the 7 ppm permitted for most agricultural products. A rule of thumb for tolerance levels is 1% of the toxic dose which is lethal to 50% of a group of experimental animals. Obviously, if 7 ppm had been estimated to be non-injurious, a tolerance of 0.05 ppm provided an unusually large margin of safety. The low tolerance was possible primarily because cows metabolize and break down DDT very effectively, and also because great attention was paid to avoiding the use of DDT on crops, such as alfalfa, which are consumed by dairy cattle. In contrast, human beings are less efficient than cows in metabolizing DDT, and they do not eat hay. There is a straight-line relationship between DDT intake and DDT level in body fat.[14] If the dosage decreases, the content of DDT in the fat becomes less. This is the result of an equilibrium level between intake, breakdown and excretion in the urine. A level of 10 ppm in the body fat is apparently harmless; far higher levels occur in spray operators and workers in DDT manufacturing and formulating factories who remain in good health despite prolonged exposure for periods up to 20 years.[15] Dr. J. M. Barnes (Director, Toxicology Research Unit, British Medical Research Council) summed up the matter as follows:

> Unfortunately, DDT is relatively slowly metabolised and excreted by the mammal and by virtue of its solubility characteristics tends to get laid down in tissue fat. Here it would have remained as an innocent and unrecognised passenger but for the fact that the chemists invented a sensitive chemical method, since further enhanced by the gas-liquid-chromatographic technique capable of detecting the chlorine and indicating its source even in minute quantities. Thus it has become possible to establish an anxiety neurosis in respect to a few parts per million of a compound in a tissue such as fat where a few parts per thousand in the whole animal are of no toxicological significance.[16]

A good example of one of the many studies on the prolonged effects of DDT on human subjects is the recent publication by Hayes and co-workers who reported that:

> Twenty-four volunteers ingested technical or p,p'-DDT at rates up to 35 mg. per man per day for 21.5 months. They were then observed for an additional 25.5 months, and 16 were followed up for five years. Storage of DDT and DDE and excretion of DDA were proportional to dosage. The fat of those receiving technical insecticide at the highest rate contained 105 to 619 ppm of DDT when feeding stopped. The average dosage of p,p'-DDT administered in this study was 555 times the average intake of all DDT-related compounds by 19-year-old men in the general population and 1,250 times their intake of p,p'-DDT. Since no definite clinical or laboratory evidence of injury by DDT was found in this study, these factors indicate a high degree of safety of DDT for the general population.[17]

DDE and DDA are two breakdown products of DDT. DDE is not insecticidal, but it has an effect similar to that of DDT in inducing the production of microsomal enzymes. DDA is an acetic acid derivative. It is inert, is soluble in water and is excreted in the urine.

The DDT in human beings enters the fat of breast milk. This was noted and published in 1950 by Laug and co-workers who found an average concentration of DDT of 0.13 ppm in 32 samples taken in Washington, D.C., with a range from undetectable ("zero") to 0.77 ppm.[18] Several similar reports have since appeared, and the results of an extensive survey were described by Quinby and co-workers.[19]

It may be concluded from the preceding discussion that the DDT level in human milk is about twice as high as the tolerance allowed for cows' milk by the FDA. That bald conclusion, however, requires explanation: it must be explained in terms of its underlying premises and toxicological implications. The use of the unqualified conclusion to create public alarm is a scientifically irresponsible act.

The DDT content of human milk has also been scrutinized by the World Health Organization and the Food and Agricultural Organization of the U.N. They set a permissible rate of intake of 0.01 mg. of DDT per kilo of body weight for breast-fed infants. The DDT intake of breast-fed babies in the United States may be higher than this; estimates range from 0.014 and 0.02 mg/kilo/day at birth, if the infant consumes 600 ml. (about 1¼ pints) of breast milk daily. As the infant grows the intake of milk on a per-kilo basis decreases because food intake per unit of body weight lessens when the size of an animal increases. Furthermore, breast-fed infants usually receive supplementary feeding with other foods.

The "permissible rate" set by the WHO-FAO, according to the chairman of the meeting that established the value, is highly conservative, and he points out that

> it offers a safety factor of about 25 compared with what workers in a DDT manufacturing plant have tolerated for 19 years without any detectable clinical effect (see Laws *et al.*, *Arch. Environ. Health*, 15: 766–775, 1967). The safety factor of the WHO-FAO permissible rate is 150 compared to the dosage of DDT given daily for 6 months to a patient with congenital unconjugated jaundice without producing any side effects (Thompson *et al.*, *Lancet* 11, (7610): 2–6, July 5, 1969).
>
> Infants are more susceptible than adults to some compounds, but the difference is seldom great—usually about 2 to 3 times. In a study of 49 different compounds, newborn rats were found to vary from 5 times less susceptible to 10 times more susceptible than adults. Although there is no information on the relative susceptibility of human infants and adults to DDT, it is shown by Lu *et al.* (*Food and Cosmetic Toxic.*, 3: 591–596, 1965) that weanling rats are slightly more resistant than adult rats to this compound, and that preweanling rats are more than twice as resistant and newborn rats are over 20 times more resistant than adults.[20]

Evidently it is possible for breast-fed infants to obtain DDT from the milk at a level up to twice the WHO-FAO "permissible rate." Again, background information indicates that no toxic effects have been detected or could be anticipated at this level. Nevertheless, the EDF and its collaborators have conspicuously proclaimed a warning that DDT may cause cancer. This adds to public apprehension, especially among nursing mothers. The question of carcinogenicity therefore should be discussed.

The "Delaney Clause" of the Food Additives Amendment[21] prohibits the use of any food additive that has been found to cause cancer in experimental animals. It is difficult to think of a more meritorious or public-spirited objective than is implied by this clause. It is even more difficult to *comply* with it, because all foods contain substances which can be shown to cause cancer in experimental animals, given the appropriate dose and the susceptible animal. All foods contain traces of radioactive elements which are present naturally. All meat products contain sterols and steroid hormones, which produce breast cancer in mice.

Pyrolysis—scorching—such as occurs in barbecuing of meat or the roasting of coffee, produces carcinogens and is only one of many examples of processes or substances in foods that can produce cancer in experimental animals when at high levels. The Delaney clause is usually regarded among scientists as being impossible either to administer or repeal. The Secretary's Commission on Pesticides, Department of Health, Education and Welfare made the following recommendation and comments:

> *Recommendation 8: Seek modification of the Delaney clause to permit the Secretary of the Department of Health, Education, and Welfare to determine when evidence of carcinogenesis justifies restrictive action concerning food containing analytically detectable traces of chemicals.*
>
> The effect of the Delaney clause is to require the removal from interstate commerce of any food which contains analytically detectable amounts of a food additive shown to be capable of inducing cancer in experimental animals. This requirement would be excessively conservative if applied to foods containing unavoidable trace amounts of pesticides shown to be capable of inducing cancer in experimental animals when given in very high doses. If this clause were to be enforced for pesticide residues, it would outlaw most food of animal origin including all meat, all dairy products (milk, butter, ice cream, cheese, etc.), eggs, fowl, and fish. These foods presently contain and will continue to contain for years, traces of DDT despite any restrictions imposed on pesticides. Removal of these foods would present a far worse hazard to health than uncertain carcinogenic risk of these trace amounts.

> Commonly consumed foodstuffs, contain detectable amounts of unavoidable naturally occurring constituents which under certain experimental conditions are capable of inducing cancer in experimental animals. Yet, at the usual low level of intake of these constituents, they are regarded as presenting an acceptable risk to human health.
>
> Exquisitely sensitive modern analytical techniques which became available since enactment of the Delaney clause permit detection of extremely small traces of chemicals at levels which may be biologically insignificant. Positive response in carcinogenic testing has often been shown to be dose-related, in that the carcinogenic response increases with increasing dose levels of the carcinogen; when the dosage of a carcinogen is minimized, the risk for cancer is also minimized or eliminated. . . .
>
> The recommendation for revision of the Delaney clause is made in order to permit determinations essential to the protection of human health, not to justify irresponsible increases in the exposure of the population to carcinogenic hazards.[22]

However, any attempt at such a revision would meet with great political opposition in the light of current fears and superstitions regarding "chemicals."

The above quotation speaks of the "uncertain carcinogenic risk" of trace amounts of pesticides. I shall review this statement with regard to DDT. The question of carcinogenicity of DDT was examined extensively starting in 1947. The above statement by the Commission was based on a recent report by Innes *et al.*[23] which is essentially a repetition of observations made about 20 years ago. The extensive earlier work on DDT and tumors in experimental animals includes about 20 articles in the scientific literature. In 1944, Lillie and Smith described hepatic alterations in rats kept on a diet containing 1000 ppm of DDT for 14 weeks.[24] Similar changes were observed repeatedly by subsequent investigators.

These findings aroused much interest and a number of toxicologists studied the effects of DDT in various experimental animals. Cameron and Burgess fed very high levels of DDT to rats, and produced liver damage that was severe enough to account for death in a number of the animals.[25] However, when the DDT was discontinued "the dead cells were removed by autolysis and phagocytic action and repair was complete without any fibrosis, although calcification was occasionally seen."[26] In plain language, if the rats were fed enough DDT to produce acute liver damage, and then the DDT was stopped, the animals got better. No cancer was found.

A more prolonged ordeal for rats, which were given a level of 100 ppm of DDT in the diet, was described by Fitzhugh and Nelson.[27] After two years, which is roughly equivalent to 70 years for a human being, a "minimal hepatocarcinogenic tendency" was noted by the authors. The authors could not decide whether the tumors were benign (adenomas) or low grade hepatic cell carcinomas.

These findings draw attention to an interesting matter known as the *dose-response curve.* It is possible to calculate the time of onset of symptoms from the daily dose of a toxic substance. If the dose is low enough, a calculation may show that the average animal will die of old age before it develops tumors. Since biological responses are subject to individual variability, the "average" animal does not represent all the animals in a group. There will be a few animals, perhaps only one in a million, that will develop tumors at a considerably lower dose than the average. This is the basis for suggesting so-called "mega-mouse" experiments (a million mice per experiment!) to detect borderline effects of mutagens and carcinogens. But in a million animals there are enough spontaneous tumors and mutations to make the results undecipherable at low levels of the chemical.

Fitzhugh and Nelson also described recovery experiments with rats on 1000 ppm of DDT for 12 weeks.[28] Extensive necrotic changes in the liver were produced during this period. The livers returned to normal after 8–10 weeks, indicating an absence of malignancy in the 12-week lesions. In these and various other studies with DDT, the minimum concentration in the diet was 100 ppm. At lower levels, the smallest detectable morphologic effect was at 5 ppm, reported by Laug *et al.*[29] These authors also reported hepatic cell changes in rabbits, mice and guinea pigs fed DDT, but the changes were not as marked as in rats. They were absent from chickens, dogs, cats, monkeys and large domestic animals. As a result, the liver changes are regarded by many pathologists as being characteristic of rodents. Various investigators have been unable to produce any pathology in rats fed DDT; indeed, the British investigators Cameron and Cheng concluded that the histological changes reported by others were "fixation artefacts."[30] These differences of opinion stimulated further research. This extensive series of publications and investigations was reviewed in 1965 by Arnold Lehman, chief of toxicology for the United States Food and Drug Administration, and his conclusion was that "DDT is not a carcinogen."[31]

The liver changes produced by DDT in rats and other rodents were described by Hayes as involving the cellular tissue that produces the "microsomal enzymes", as being reversible, and as being peculiar to rodents.[32] He also pointed out that the changes could also be produced by phenobarbital, by pyrethrum (a "natural" insecticide), by ethyl alcohol and by oxidized fats. The microsomal enzymes have various effects including the breakdown of some toxic substances and certain hormones.

The allegations by the EDF that DDT is a carcinogen are based primarily on three reports. The first is an article by Innes and co-workers with mice, which the authors call a "preliminary note."[33] Just why it was necessary to publish a "preliminary note" on a subject (the effect of DDT on rodents) that had been covered exhaustively over a period of ten years by a large number of experiments is not clear. The amount of DDT fed was the maximum tolerated dose, 140 ppm in the diet, and the experiment lasted 18 months, which is most of the lifetime of a mouse. The results were as follows:[34]

Supplement (and no.)		Level used		% Mice with tumors		
		mg/kg*	ppm	Hepatomas	Lung	Lymphoma
None (controls)	(338)	—	—	4.1	6.2	4.1
p,p'-DDT	(72)	46.4	140	31.9	5.5	10.9

* Dosage was oral for 7–28 days, then added to diet.

In confirmation of experiments reported earlier by other scientists, there was an eight-fold increase in hepatomas over the controls, and a borderline effect on lymphoma, to which mice are highly susceptible. Hepatomas are defined as tumors that are on the borderline between benign and malignant. Dr. Hayes commented as follows:

> Innes, *et al.* (1969) reported that the tumorigenicity of selected pesticides and industrial compounds was tested by continuous oral administration to both sexes of two hybrid strains of mice, starting at the age of 7 days. The chemicals were given by stomach tube until weaning and thereafter as a mixture in the diet. Maximal tolerated doses were given for the entire period of observation, about 18 months. The authors stressed that the dose received by the mice was far in excess of that likely to be consumed by humans. One of the compounds that gave a statistically significant positive result was DDT. The incidence of tumors was comparable to the mean tumor incidence

produced by a group of positive control compounds, most of which are weak or even questionable carcinogens of no demonstrated importance to human health. The authors made no distinction between hepatomas and carcinomas. It is difficult to understand why, in denying the practicality of making this important distinction, they entirely neglected the matter of reversibility. A full account of the study is promised later. In the meantime there is no assurance that the small number of tumors observed in mice exposed to DDT were different from the "nodules" described by Fitzhugh and Nelson in 1947.[35]

In this experiment, the mice received about 3000 times as much DDT in their diet as is consumed by people in the United States. It is primarily on this experiment that the allegations rest that DDT causes cancer. The other two reports are trivial; in one of them the diet of mice was suspected of being contaminated[36] and the second was based on a far-fetched inference which one of the authors (Deichmann) later "soft-pedaled."[37] The inference was that DDT was found in higher concentrations in fatty tissues of persons with terminal degenerative diseases than in fatty tissues from "normal" autopsy samples. However, such terminal diseases are usually accompanied by emaciation, which would concentrate the DDT in the remaining fat, and Deichmann, *et al.* have commented that the "investigators did not demonstrate a causal relationship between those diseases and pesticide retention in body tissues."[38] Yet a causal relationship is repeatedly emphasized by the lawyers for the EDF, the National Audubon Society and the Sierra Club.

The argument over DDT and cancer is important because millions of lives hang on it. If DDT were officially tabbed as a carcinogen in the United States, its use in the world-wide malaria control program would be severely inhibited or even stopped. What would this do? Ceylon has provided an excellent object-lesson:

> Following a country-wide malaria eradication campaign in the 1950's and early 1960's, the number of confirmed malaria cases reached lows of 31 in 1962 and 17 in 1963, when full-scale house spraying was partially withdrawn, and subsequently terminated in 1964. The cases increased annually thereafter, numbering 150 in 1964, 308 in 1965, 499 in 1966, and 3466 in 1967, most of them occurring in the last few months of that year. In 1968, the epidemic flared rapidly—16,493 confirmed cases being reported in January and 42,161 in February. No DDT supplies were on hand with which to reinstate the house

> spraying program on the wide scale needed, and months were required for the procurement and delivery of them. As a result, more than a million cases of malaria occurred throughout the country in 1968.[39]

What is the *real* effect of DDT on babies? Let us reverse the coin—What is the effect of malaria? Burnet had something to say on this. He wrote in 1953 that malaria

> is the great devitalizer of the tropics. . . and it is the main agent of infantile mortality. If malaria could be suddenly eliminated from the globe, the racial, economic and political consequences within a very few years would probably be appalling. India and parts of Africa are populated up to and beyond the capacity of the land to provide adequate food by present methods, and even with the tremendous infantile and prenatal mortality caused by malaria, the populations are increasing steadily. The sudden conversion to a more vigorous and rapidly increasing population would undoubtedly produce famine (emigration) and intense internal and external social repercussions.[40]

Nine years after Burnet's article, the effects of the anti-malaria program in India were described by Pal:

> The control programme [with DDT] was launched in April, 1953 and it was designed to give protection to 200 million people living in the malarious areas of the country.... Improved knowledge on malaria control led to the revision of the original strategy and the aim became the eradication of the disease for the entire sub-continent. In April, 1958, the National Malaria Eradication Programme was launched. It consists of three phases: attack, consolidation and maintenance. The attack phase is aimed at total interruption of transmission by spraying with residual insecticides all roofed structures throughout the country.... Since 1953, about 147,593,270 lb. of DDT have been used, with small amounts of BHC and dieldrin. As a result, malaria morbidity has been significantly reduced in the country. The proportional case rate of malaria (per cent of malaria cases to total diseases as clinically diagnosed) in each year of this programme has shown a decline.... Estimates of actual morbidity and mortality are difficult but it would appear, from the available data, that malaria in India has been reduced from 75 million cases to less than 5 million. A new era in economic development and social progress has been initiated with its beneficial transformation of the life of the people. The average span of life in India is now 47 years, whereas before the eradication campaign it was 32 years. This improvement has resulted in better agriculture and industrial production. In the Terai region (Uttar Pradesh), land under cultivation and food grain production

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has increased and this region, once abandoned by its inhabitants because of the high incidence of malaria, has become a beautiful and prosperous area.[41]

WILDLIFE, NATURE STUDY AND INFERENCES

It is often difficult to obtain controlled and reliable results on the question of toxicity of chemicals to wildlife under field conditions. The temptation to blame pesticides indiscriminately for the death of wild creatures seems irresistible to organizations committed to the protection of wild animals. A trace of DDT reported in a dead bird or fish often triggers a chain reaction of publicity and incrimination. On the other side of the ideological fence, the farmers and entomologists give considerable weight to the fact that, in order to be able to eat and to protect themselves against major diseases, human beings must vigorously wage war on noxious insects. Chemical pesticides are essential in this fight. The release of pesticides into the environment, and the presence of traces of pesticides in our food, are inevitable if the human race is to maintain its present numbers and control of disease. It is obvious, or course, that the use of pesticides must be kept down to the minimum level commensurate with adequate crop production and disease control.

Modern agricultural technology as practiced in the United States is a development that has taken place largely in the past half-century, with major advances in the last 25 years. Geneticists, chemists and engineers have made great contributions to increasing the food supply and simultaneously lifting the burden of toil from farming. The easy availability of food has accelerated the movement of people to the cities.

Food is never pure. In the 1930's, contamination of food by pests was a major problem; for example, canned vegetables were spot-checked for pieces of insects. Today much testing is done for pesticide residues. With rare exceptions, the amounts found are well below the tolerances, which in themselves are far below the toxic levels. Pesticide residues in foods are not a public health problem. The absence of such residues could be brought about by stopping the use of pesticides. This would create a real problem—food shortages.

It would not be possible to reverse this movement and replace chemical technology by hand labor on farms without a great social dislocation. If chemical herbicides are not to be used, "the man with the hoe" must return to the farm and work long hours. In China, until recently, grasshoppers were killed by hand, but most of the major pest insects are too elusive for even this archaic procedure, and "biological control" can play only a minor part in keeping such insects from destroying crops.

Many of the charges that DDT destroys wildlife are based on inference. Often the charges have been based on tests that appeared to detect traces of DDT or other pesticides, and no consideration was given to the quantitative aspects of the results. Sometimes the effect of non-pesticide factors is disregarded or ignored. An example is the occurrence of large numbers of dead fish in the lower Mississippi River. This was blamed, with great fanfare, on pesticide contamination of the water. Subsequently the deaths were attributed to bacteria, *Aeromonas liquefaciens*, and to a lack of oxygen resulting from run-off of flooded fields.

The decline of the crab catch in the vicinity of San Francisco in 1969 was blamed on DDT. A scare article and banner headline appeared on the front page of the *San Francisco Chronicle* stating that the decline resulted from the toxic effects of DDT.[42] The story warned the public that crab meat might be contaminated. Strangely enough, the crab fishery further north on the California coast reported record catches for three seasons, and the most recent one was 14 million pounds (making one wonder whether the species will be "fished out"). In November, 1970, another San Francisco newspaper headlined: "What Happened to Our Crabs? Pollution!"[43] The article stated:

> The dumping of millions of gallons of highly poisonous wastes off the Farallones is probably responsible for the drastic slump in the San Francisco crab fishery.
>
> State Fish and Game Biologists Don Lollock and John Ladd in a report to the Regional Water Quality Control Board said that although absolute proof is lacking, evidence of the decline points to the oceanic pollution.
>
> The catch has dropped from a high of nearly nine million pounds in the 1956–57 season to 1.4 million last season.
>
> The biologists recommended the board take prompt action to stop such industrial waste discharging.
>
> On receiving the State Fish and Game Department document, the board yesterday took emergency procedures to place the subject on the agenda for action at its Dec. 22 San Francisco meeting.
>
> Three firms use the ocean for major dumping. U. S. Steel, given a Dec. 15 deadline yesterday for improving the quality of discharges

> from its Pittsburg works, dumps in the neighborhood of 15 million gallons of acid steel waste containing sulphuric and hydrochloric acid annually.
>
> Sulfates and large concentrations of heavy metals also are barged and unloaded in the Farallones Gulf, nine miles from the City.[44]

What happened to our crabs? What happened to the DDT that was blamed in 1969?

DDT was found in the livers of dead sea lions on the coast of California in the late summer of 1970, and, as usual, the newspapers swung into action to condemn the insecticide. In November, a memorandum was issued by Dr. Richard Hubbard of the Marine Mammal Study Center, Fremont, California, describing the findings of a team that had diagnosed the deaths as being due to leptospirosis. The diagnosis was based on symptomatology, post-mortem findings, identification of *Leptospira pomona*, blood antigen tests and epidemiology. He commented that "there is no correlation between mercury and DDT levels, and sick animals." But, by November, who was interested? Certainly not the EDF. *Leptospira* is "part of the environment."

Robinson Jeffers has written, "Give your heart to the hawk." The bird protection societies would seemingly have us follow this admonition and, indeed, the speed and audacity of the bird of prey appeal to the Walter Mitty who lurks in most of us. Eagles have many admirers, while chickens (at least, while alive) have but few. The dire warnings that bald eagles were threatened by DDT were enough to arouse horror against this insidious chemical. For example, a photograph on the cover of *Science*[45] showed a bald eagle's nest with one unhatched egg and one apparently healthy eaglet. The failure of one of the eggs to hatch was attributed to the presence of DDT in fish in the Great Lakes area. But is the story true?

An examination of scientific literature which antedates the extensive use of DDT is instructive. It reveals that even in such earlier years the survival of the eagle was deemed a critical issue. For example, in 1921 an article entitled "Threatened Extinction of the Bald Eagle" appeared in *Ecology*. In 1943, F. Thone stated in *Science News Letter*: "When the timber was cleared, it was inevitable that the eagles had to go. Moreover, the cities grew and befouled the rivers with sewage and industrial wastes. The once teeming fish population vanished."

The Territory of Alaska paid a bounty of 25 cents per claw for 115,000 bald eagles assassinated between 1917 and 1952. There are now an estimated 7000 bald eagles in Alaska, about 6% of the number that was slaughtered. Gunfire continues to be the main cause of death of bald eagles, according to United States Department of Interior figures: of 76 dead specimens examined between 1960 and 1965, 44 were shot, 7 died of impact injuries, 3 of other violent forms of death, 4 of disease or old age, and the remaining 18 of undetermined causes. More recently, the same Department has reported "poisoning from dieldrin in growing numbers of bald eagles found dead in the United States"[46] and also that mercury poisoning has been detected in bald eagles.[47] The last finding draws attention to the presence of potentially toxic levels of mercury in fish in the Great Lakes, and suggests that mercury may be the cause of reproductive failure in the bald eagles in this region.

Why was DDT blamed? As George Mallory said of a certain mountain, "Because it was there."

How are the eagles doing? According to the National Park Service, a record number of 373 bald eagles, 120 of which were immature, were counted on November 20, 1969, below Lake Macdonald in Glacier National Park and 268 (with the birds still flying in) on November 25, 1970. The percent of immatures has held "a steady 31" during the past five years. This meant, according to the Park Service, that the birds came from "areas not yet seriously affected by pesticides," an explanation which is on a logical par with stating that the birds are alive because they are not dead. Evidently pesticide poisoning plays no more than a minor role in the demise of bald eagles. The alleged effects of DDT are now being second-guessed in favor of other chemicals.

In Scotland, the use of dieldrin in sheep dips was concluded to be the cause of a decline in the breeding ability of the golden eagle, which eats sheep carrion. This use of dieldrin was discontinued in 1966, following which there was an improvement in breeding success in golden eagles.[48]

The story of the peregrine falcon is similar in many respects to that of the eagle, except that the peregrine is even rarer. It is not only the object of man's hostility because it eats racing pigeons, but it is also harassed by the robbing of its eyries to provide young birds for falconry, and eggs for collectors. The peregrine falcon is considered as no longer breeding in the eastern United States. However, the counts of migrant peregrines at Hawk Mountain, Pennsylvania, were as follows:

1935-1942	ave.	32
1967		22
1968		21
1969		26
1970		27

It is obvious that the peregrine was rare even prior to 1940; the total annual count of hawks at Hawk Mountain ranges between 10,000 and 20,000.

The rapid decline of the peregrine in the eastern United States took place prior to the introduction of organic pesticides,[49] and seems to have been caused by harassment.[50] The peregrine population in the eastern United States is estimated as having been something less than 275 breeding pairs in 1940. In contrast, the peregrine population in Northern Canada and Alaska is reported to be thriving and was estimated by Fyfe (1969) as about 7,500 breeding pairs.[51]

Whether or not counts like those above can be read as linking DDT with animal deaths, the counts must be kept in proper perspective. All such statistics should be reviewed in the context of other "human" statistics. One cannot ignore, for example, that before the advent of DDT, 2000 *people* per *day* were dying in India from malaria.

Other analyses have been made of the effects of DDT on the peregrine. High levels of DDT and its metabolites were reported in the fat of peregrine falcons in the Yukon[52] but a "seemingly normal average" of viable eggs and young was found in 15 nests in this region. Fat biopsy samples from nine females had an average content of 37 ppm DDT, 284 ppm DDE and 40 ppm TDE (DDD). The samples also contained an average of 3.3 ppm dieldrin and 4.4 ppm heptachlor epoxide. During this survey, the nests were robbed to obtain eggs for analysis, and female falcons were trapped and slit open to take samples of body fat. Following this, the unfortunate birds were sutured and released, after which they "showed normal behavior." One wonders how long they survived. The authors noted that the eggs were taken from eyries where reproduction was normal and averaged about 27 ppm of total organochlorine residues. Ratcliffe stated that the residues in eggs from unsuccessful eyries were 17.4 ppm; these were to be compared with the residues of 12.7 ppm in eggs from successful eyries in Great Britain.[53] The disparity between the two sets of findings suggests that the reason for reproductive failure in the peregrine has not been identified.

The British Advisory Committee on Pesticides and other Toxic Chemicals, in a comprehensive review on organochlorine pesticides published in 1969, stated:

> There is no close correlation between the declines in populations in predatory birds, particularly in the peregrine falcon and the sparrow-hawk, . . . and the use of DDT. Therefore DDT does not appear to have been the principal cause.[54]

In summary, the peregrine as a breeding species in the eastern United States appears to have been extirpated primarily by harassment, and no role for DDT has been shown. The peregrines in northern Canada are breeding successfully despite high tissue levels of organochlorine pesticides. The current reduction in the use of these pesticides should tend to a lowering of these levels, and the future of peregrines in this region does not appear to be in jeopardy.

The osprey, or fish hawk, was a conspicuous species along the eastern seaboard of the United States, even in populated areas such as Gibson Island on Chesapeake Bay. A decline in the population of ospreys in such areas has been attributed to DDT. Harassment seems more likely to be the major cause, because the osprey is evidently increasing in the eastern United States and Canada. An obvious explanation is that the birds have moved away from the region of suburban developers and outboard motors in search of peace and quiet. The osprey count at Hawk Mountain averaged 172 per year from 1935 to 1942, pre-DDT years. Recent counts are:

1965	444
1966	405
1967	467
1968	403
1969	530
1970	600 (a record high)

The counts at Hawk Mountain must be interpreted with care, because up until about 10 years ago there was only one look-out, and now there are three, at least two of which "are manned every day, all day, from mid-August through November," according to Dr. J. W. Taylor, who estimates that 20 years ago, under today's conditions, the "number of hawks seen would have been at least three times, and probably five or six times, what our figures in 1969 show." Dr. Taylor nevertheless states that "the

Osprey population on the interior lakes has greatly increased, and these are the birds we are now seeing at Hawk Mountain."

Naturally all of us hope that hawks and eagles will survive the onslaughts of human interference. However, blaming DDT seems a convenient excuse. If a species is still being counted at Hawk Mountain, it is obviously *not* extinct, and if the numbers have not decreased greatly in recent years an interpretation that the species is drastically declining is questionable in the absence of further study.

DDT AND PHOTOSYNTHESIS IN THE OCEAN

DDT is said to be steadily accumulating in the seas by distillation from the surface of the land, by drainage into rivers and by the blowing of dust. It is also alleged that DDT is, in effect, indestructible, because its principal metabolite, DDE, resembles DDT in inducing the production of microsomal liver enzymes. One of the most sensational anecdotes about DDT is the prediction that it will stop photosynthesis in the oceans, as a result of which life on Earth will become extinct. This story was repeated by diverse authorities ranging from U Thant to Ehrlich, who stated[55] that it originated in Wurster's report.[56] This report described the effects of adding graded amounts of an alcoholic solution of DDT to algal cultures in sea water and measuring photosynthesis by carbon-14 uptake. The DDT was added to produce concentrations up to 500 ppb. Not surprisingly, photosynthetic uptake of carbon-14 was depressed at the higher levels, since DDT is phytotoxic above certain levels. Its maximum solubility in sea water is 1.2 ppb, and DDT would be precipitated and adsorb to the algae above this level. The results as presented by Wurster show that at the points corresponding to 1 and 2 ppb, there was no depression of carbon-14 uptake.

The findings at these levels were as follows:[57]

Species	Effect of DDT on C^{14} Uptake*	
	1 ppb	2 ppb
Skeletonema costatum	−	−
Coccolithus huxleyi	+	+
Pyramimonas sp.	−	+
Peridinium trochoideum	+	+
Mixed culture**	+	+

* Increases over controls, +; decreases −.
** Typical neritic phytoplankton community.

According to these fragmentary findings, a saturated solution of DDT in sea water would not depress photosynthesis. Wurster states:

> The fact that these data apparently follow sigmoid curves is typical of dose-response relations and suggests the absence of a threshold concentration of DDT below which no effects occur. Experimental scatter produced some uptake of C^{14} above 100 percent at low concentrations of DDT, however. This should not be interpreted as a low-level stimulatory effect, a possibility that cannot be evaluated from these data.[58]

Obviously if the data show an indication, even slight, of a low-level stimulatory effect, it follows that the same data cannot be used to postulate a "no threshold" situation. Wurster pointed out that "water near a direct application of DDT to the environment, however, commonly contains concentrations comparable to those applied by me."[59] This is a far cry from stopping photosynthesis in the oceans as suggested by Ehrlich. Wurster goes on to state that "selective toxic stress by DDT on certain algae" may "favor species normally suppressed by others, producing population explosions. . . . Such effects are insidious."[60] (The word "insidious" is a favorite word in the lexicography of DDT.) Increases and decreases in aquatic photosynthesis can both be blamed on DDT. It is a well-documented observation that over-application of DDT to green crop plants may cause not only depression of photosynthesis, but death. Over-application of various chemicals kills plants; common salt, for example, used to be used as a weed-killer.

To produce a concentration of 1 ppb of DDT in the 300 million cubic miles of sea water in the oceans would take 9,000 years if the total annual production of DDT, 300 million pounds, were dispersed in the oceans each year and there was no breakdown. If the half-life of DDT in sea water is one thousand years or less, this concentration would never be reached.

The absurdity of these figures illustrates the need for quantitative examination of allegations, but is not intended as a suggestion that it is safe or desirable to use the ocean as a sink for pollutants.

CONCLUSION

This article has treated only a few of the points that demonstrate DDT's ultimate safety and significant contributions to man. I have chosen to discuss these few points at length, rather than to mention a large number of topics briefly. A final response, however, must be made to the charge that DDT has injurious effects on human beings. The particular charge to which I respond is based on the observation that DDT inhibits certain enzymes in laboratory experiments. Contrary to what DDT opponents would have us believe, a similar observation can be made of any of a number of substances. For example, many of the substances that we eat—salt, phosphate, magnesium, citric acid—drastically affect enzymes in test tube experiments. These experiments, moreover, do not involve intact animals. By contrast, the everyday use of DDT does involve intact animals, and the effects are remarkably minimal. In point of fact, *several hundred million people* have been exposed to DDT for prolonged periods of time without any sign of ill effect. Some of them have received heavy doses, over periods at up to 19 years[61]—the 130,000 spraymen listed by the WHO, for example, and numerous people in DDT factories and formulating plants—all without any reports of illnesses attributable to DDT. In the 1940's, enthusiastic volunteers allowed themselves to be used as experimental animals and swallowed large amounts of DDT, in some cases daily for prolonged periods.[62] For some reason, nothing seemed to happen except transient tingling of the extremities. Some day the true story of DDT, buried in the scientific literature, will be brought out into the open.

We may certainly expect an increase in dialogue between scientists and lawyers as the number of legal questions involving the environment grows apace. Such dialogue, however, when it occurs in the tightly structured setting of the courtroom, may have unfortunate consequences. If a scientist is asked, for example, whether a pesticide is poisonous, he will say "Yes;" at the same time, however, he may recommend its use at an appropriate level as a proper response to human needs. A skillful attorney can effectively exploit such an apparent contradiction, following which the scientist will probably withdraw into his shell. In the 1969 Wisconsin hearings on DDT, such incidents repeatedly took place during examinations by Environmental Defense Fund (EDF) attorney, Victor J. Yannacone, Jr. An EDF spokesman, C. F. Wurster, expressed much satisfaction with Mr. Yannacone's efforts:

> Victor J. Yannacone, Jr., the Environmental Defense Fund's at-

> torney, has an impressive grasp of scientific material, especially the environmental sciences. His cross-examination is usually aggressive and may be devastating where a witness is scientifically weak.[63]

Wurster, however, later altered his opinion. On March 9, 1971, he stated:

> It has come to my attention that certain remarks, attributed to me by Mr. Victor J. Yannacone, Jr. in May 1970, have been inserted into the record of your hearings on pesticides during the testimony of Edward Lee Rogers of the Environmental Defense Fund.
>
> I wish to deny all of the statements of Mr. Yannacone. His remarks about me, attributable to me, and about other trustees of EDF are purely fantasy and bear no resemblance to the truth. It was in part because Mr. Yannacone lost touch with reality that he was dismissed by EDF, and his remarks of May 1970 indicate that his inability to separate fact from fiction has accelerated.[64]

Yannacone's fiery and uncompromising onslaught on DDT in Wisconsin was evidently undertaken for the purposes of advocacy, for on September 27, 1970, he said, in comparatively moderate tones:

> Any law simplistically banning the use, sale, manufacture or distribution of DDT in your state, county, city or even the United States, without at the same time establishing an ecologically sophisticated pesticide regulation program, is a bad law. It won't satisfy anyone very long and will permanently polarize agriculture and conservation to such an extent that common problems can no longer be considered in rational discourse.[65]

These remarks by Mr. Yannacone reflect a scientific sophistication that he did not reveal during the Wisconsin hearings. Regrettably, however, the earlier remarks seem to have gained greater attention.

This anecdote serves to illustrate an essential difference between the advocate and the scientist. The advocate seeks a prompt and unequivocal decision on a particular issue. The scientist, however, simply cannot expect such results; he thus strives to obtain facts which enable him to ascend the spiral staircase of knowledge. With each step of his ascent, he obtains a wider and superior view of his subject matter, and, although he never reaches the top, he should on his way up help his fellow men by telling them what he sees.

* * *

Footnotes

[*] Professor of Medical Physics, University of California, Berkeley.

[1] J. Slater, "Third World Ecology Course to Be Offered," *The Journal of Educational Change* 2:1 (Oct. 1970).

[2] Rachel L. Carson, *Silent Spring* (1962).

[3] Advertisements by National Audubon Society, 1970, in various magazines.

[4] "Our Ecological Crisis," *National Geographic Magazine* (Dec. 1970).

[5] U. S. Court of Appeals, District of Columbia, Circuit Petition for Review of Order of U. S. Dept. of Agriculture, No. 23, 813 (Apr. 6, 1971).

[6] Martin G. Garcia (WHO), Personal Communication to S. Rotrosen (June 19, 1969).

[7] See P. DeKruif, "The Magic Bullet," *Microbe Hunters*, p. 308 (1926).

[8] R. Pal, "Contributions of Insecticides to Public Health in India," *World Review of Pest Control* 1:6 (1962).

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Scientific Agriculture At The Crossroads

Thomas H. Jukes

What is the matter with farming? Why is the food supply being attacked and criticized? Why has the safest of all the pesticides been banned? Why are many people paying fancy food prices for off-grade "organic" junk? What does all the hullabaloo about additives, residues and cancer mean? Why can a few sensation-seeking "scientists" give a safe food-seasoning compound a black eye? Why does the public listen to scare stories about food told by people who simply don't know what they are talking about? Who would have dreamed ten years ago, that the California State Departments of Agriculture and Health would back a Bill setting standards for "organic foods"? - instead of prosecuting the merchandisers who peddle this shabby fraud!

What is going to happen to California agriculture; the pride and wonder of the farm world; the provider of delicious fruits and vegetables to the USA?

Plenty, unless some sense is brought into the situation. Don't look for any help from the so-called "environmentalist movement", run by city lads and lasses who live in automobiles and air-conditioned apartments, and who blandly tell you that "modern agriculture is an ecological disaster"! (When is someone going to tell them that the farmer is a professional environmentalist who understands and cares for his patch of Mother Earth better than any eco-activist?)

How did we get in this fix? I have tried to think of some of the reasons. Here they are:

1. The rejection of "establishment" scientific values by the counter-culture. It is "hip" to disbelieve just about everything that is "in the books". Listen to this statement in an article written for (get this!) the "Journal of Nutrition Education," vol. 4, p. 48 (1972): "There is at least one advantage in entering the field as belatedly as I did at the graduate level. I seem to have avoided the undergraduate conditioning which has made it so difficult for many more experienced professionals in the field to look objectively at the American food supply. One of the things that troubles many dietitians and nutritionists is the difficulty they have had in freeing themselves from. . .the 'Nutritional Dogma'. The tenets of this dogma are brief: 'Americans are the Best Fed People in History' and 'The American Food Supply is the Best in the World.'" (So University education is undergraduate conditioning!)

2. The success of "Silent Spring", with its theme that foods contain poisonous residues placed there by industry, e.g., Chapter 11 is entitled, "Beyond the Dreams of the Borgias". This bone-chilling science fiction story-book has sold over a million copies, is used as a text in schools, and is Holy Writ to the new cult of Environmentalism. The publishers are trying to pump new life into the book by printing follow-up volumes, and a Life of Rachel Carson.

3. The flood of imitators of "Silent Spring" including the disciples of Nader and Commoner, and magazines such as "Environment". Naturally, the imitators have to go one better than the original, so as to catch the public eye.

4. The increase in sensitivity of analytical methods to the point where many or most biological materials can be shown to contain residues of substances commonly regarded as poisonous, carcinogenic, mutagenic, etc. These refined methods also show the presence of traces of pesticides, hormones, etc., and publicizing these residues has caused widespread distrust in scientific agriculture. Furthermore, it doesn't seem to matter to some of those who do the talking whether a residue is one part per thousand, per million, or per billion. If a substance is toxic at a level of 0.1%, why, it must be dangerous at 1 per million, mustn't it? This line of non-reasoning has aptly been likened to comparing the effect of a faint breeze to the damage found in the wake of a hurricane.

5. The "Delaney Clause" in the Food Additives Amendment. The enforcement of this clause is incompatible with (4). The Delaney Clause (known usually as the "Delaney Amendment") says that "No (food) additive shall be deemed to be safe if it is found to induce cancer when ingested by man or animals". The same legislation also provides that "No such additive may be used in animal feeds unless no residue of it can be found in food products obtained from the animal after slaughter." This means that no level of residue of any "carcinogen" is tolerable - presumably not even a single molecule. It sounds great, except that carcinogens, as defined by the Clause, are naturally present in all animals, and are also present in most foods of plant origin and always have been. With a little effort, all sorts of things could be labeled carcinogens - toast, coffee, vitamin A, barbecued beef, cabbage. Of course it is essential to have a law against adding cancer-causing substances to foods. Such a proviso, that of safety, was in the Food Drug and Comestic Act before the Delaney Clause was added. The Clause automatically places a ban on any additive that gives a positive test as a carcinogen, without permitting evaluation of whether the additive has a "threshold level" below which it might not be biologically active.

6. The existence of a phalanx of reporters, television commentators, etc., untrained in science, who are able to command attention with horror stories about residues in foods. What better build-up can a television personality give himself than to come out for wild birds (a brown pelican is shown flying in the background on the TV screen at this point) and against DDT?

7. Handsome financial rewards for "Doomsday" protagonists, who can command high fees for lectures to "make the audience's flesh creep." One of them even alludes to the fact that he has had himself vasectomized.

8. Publication of misinformation about nutrition by scientists who are prominent in other fields, such as allegations that vitamin C has extraordinary therapeutic properties. If ascorbic acid "Prevents The Common Cold," why shouldn't it cure cancer?

9. The existence of a cult of food quackery whose high priests have now "come out of the woodwork" and are attracting wide public attention which was formerly denied them. The audience is no longer bored and skeptical concerning nonsense about food and nutrition. The quacks have moved into the intellectual vacuum caused by rejection of established values. Look at the stacks of organic food literature beside the cash registers at the grocery store. Then try reading some of it - it will tell you how to cure gray hair with cold-pressed vegetable oil, cancer with apricot pits, and infectious diseases with herb teas.

10. The urbanization of the American population so that most people are completely ignorant of the chemical technology that is necessary for agriculture. Their parents seemed to believe that food grew out of the floor

(Continued on page 10)

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of the supermarket, but the children are smarter - they know that food grows in health food stores.

11. The firm conviction by the more vocal intellectuals that capitalism is evil, and that the American free enterprise system is a heartless, greedy, polluting monster, out to do the consumer in. Why is this idea so prevalent? You will have to ask someone other than me. I think the consumer is better off here than in most countries. I came over on a boat when I was 17, and I like the place. Especially when I read books by Alexander Solzhenitsyn.

How did we get where we are in agriculture?

Two hundred years ago, the average family in the western world, just as in many of the disadvantaged countries to-day, had to spend most of its time grubbing a meager living from the soil. The lack of fertilizer, the presence of pests that demolished crops, and the absence of knowledge about plant-breeding all combined to keep most people hungry. Then chemists discovered that plants were actually nourished by chemical, or inorganic, fertilizers. Phosphate, potash, nitrate and ammonia were needed, and they could come either from the breakdown of manure by soil bacteria, or from rock phosphate, inorganic potash, nitrates and salts of ammonia. The agricultural revolution was on. With it started the industrial revolution and the waves of migration to the cities. As the years went by, the farmers fed more and more "city folk". You would not be reading this if it were not for the fact that one farmer in the U.S.A. now produces, on the average, enough food for more than forty nonfarmers! Chances are you would be out hoeing weeds.

But one thing was missing a century ago - pesticides. This lack resulted in the Irish potato famine, in which a fungus blight turned the potato crop into a stinking black slime. One million people starved to death. Many of the survivors fled to the New World. They and their descendants worked hard and gave many great citizens to our country. And chemists solved the problem of the potato blight. It is still in the fields, but it is controlled by pesticides.

As agricultural knowledge increased by leaps and bounds, farming became increasingly scientific. Plant and animal breeding gave us fine new strains of grains, vegetables, fruits, poultry, pigs and cattle. Delicacies that the average family could buy only once or twice a year are now in every supermarket, everyday. The new methods required careful regulation to see that the chemical tools for the farmers were properly used. Pure food laws were passed to make sure that only insignificant traces of unwanted residues were present in foods. As a result, millions of tons of food have been eaten by millions of people without a single case of illness in America being attributable to an approved procedure in scientific agriculture. In contrast, in countries where "organic fertilizers, such as human waste, are used, food poisoning often results from intestinal disease organisms. For Nature is not kind to us. Deadly bacteria can lurk in putrid food and in the soil. Molds can produce cancer-causing substances in food.

A major part in solving the problem of food protection was played by acceptance of the principle of comparative toxicity. This says that if a chemical, such as a pesticide or a food additive, is used, the residues in food should be such that a daily portion of the food will contain no more than one-hundredth of a dose toxic to human beings. The toxic dose is often measured on two species of laboratory animals through a complete generation. In other words, we are trading off a large benefit - an abundant and cheap food supply - for a very small risk - the risk that one-hundredth of a toxic dose may be harmful. The trade-off has been a colossal success; so successful that an entire generation of healthy young people have been raised on food produced with the aid of pesticides and additives. As a direct result of the modern agricultural revolution, life is so easy that many people have nothing better to do than nit-pick. The voice of the prophet of Doomsday is heard in the land, proclaiming that bacon will cause mutations, that sex hormones will lead to cancer, and that antioxidants and mold preventives will keep food fresh beyond the time when it, by all rights, should be rancid and moldy, so therefore preservatives are bad. An article in an Eastern magazine said that the crops of the San Joaquin Valley were "poisoned", and that the "green landscape" was "lifeless". What nonsense!

How did the big chemical companies oppose the campaign against DDT? They had a perfect answer. They bugged out. They quit making DDT. This is what the eco-activists would like to see happen to scientific agriculture in California. Quit using fertilizers, pesticides and big machinery! Back to the dung heap, the fly swatter and the hoe! The Santa Cruz campus of the University of California has bought some horses to do the farm work. The Sierra Club advocates taking livestock out of feed lots and putting them back on the land; only sixty years after John Muir won his fight to drive the sheep out of Yosemite. If the critters in feed lots are to be sent back to the land, they won't be put in the peach orchards, vineyards and lettuce fields.

They will be turned out to graze in the National and State Parks.

Does it do any good to write this article for readers who are already convinced of the value of scientific farming? Only if you will get busy and tell other people about it. Remember that they are being snowed by the organic food propagandists. Here are six samples from "PREVENTION", a monthly publication of the Rodale Press:

(1) "Nature's Own Answer to Graying Hair" (April 1972) The article states that brewers' yeast, liver, wheat germ, black-strap molasses, sunflower seeds, whole grain cereals, rice polishings, sea food, kelp, yogurt and cold pressed vegetable and nut oils "have been found helpful in restoring original hair color". This is false. These foods are standard items, of course, in the "health" food list.

(2) "Is there an anti-cancer food" (April 1972) This is a plug for "seeds" containing amygdalin as preventing cancer. The heartless racket of using apricot seeds to treat cancer patients has been exposed by the California State Department of Public Health.

(3) "Nearsighted? Look to your diet" (May 1972) The article states, "The kid who loves sweets is unknowingly weakening his eyes." Unsubstantiated, misleading, and getting into the field of medicine without a license.

(4) "How a naturopath works" (May 1972) Red pepper is recommended for removing nasal obstructions, and herb teas as replacements for antibiotics in treating infections. Pass the powdered rhinoceros horn.

(5) Same issue, p. 85, says that the USDA does not include soybeans, turkey, beef kidney, rice, codfish, halibut or flounder in listings of nutritive value of foods. The standard USDA publication on this subject is the well known Agriculture Handbook No. 8, "Composition of Foods". This Handbook is used very widely by nutritionists. It lists 18 entries for soybeans and soybean products; 14 for turkey; one for beef kidney; 16 for rice and rice products; 5 for codfish; 6 for halibut and 2 for flounder.

(6) "Bone meal is old age insurance. Wheat germ oil strengthens the body in periods of great stress" (September 1972) More examples of misleading and false therapeutic claims. In addition, this publication is packed with sensational and misleading advertising.

Legislators and governmental departments would do well to focus their attention on exposing food quackery to the public rather than [illegible]eking to provide legislative approval and official labeling for a myth which is costly and misleading to the consumer. Those who produce cereals, meat, fruit and vegetables by legitimate, conventional means are entitled, scientifically and in point of fact, to label their products "organic", because the dictionary defines this term as "derived from living organisms."

Without chemical fertilizers, pesticides, food additives and medicines for farm animals, it would be impossible to feed the people in the U.S.A. or in the world. And legal measures to counteract the practice of scientific agriculture are against the public interest.

Dr. Thomas H. Jukes is a scientist of world renown. Currently professor-in-residence, medical physics, University of California, Berkeley, he has made outstanding contributions to the science of nutrition, and developed an international reputation in the field of molecular evolution and the genetic code. Firmly convinced that science should help to relieve hunger and disease, he has become a famous defender of DDT, agricultural chemicals and scientific farming.

Among Dr. Jukes' discoveries were the identification of pathothenic acid as a vitamin, that nicotinic acid cures pellagra, that crystalline riboflavin is necessary for chick growth, that vitamin B-6 dificiency causes convulsions in babies, that choline is an essential in the diet of turkeys, and the roles of folic acid antagonists in cancer chemotherapy. He is the author of three books and of 225 articles and book chapters on these and related subjects.

Emigrating from England at the age of 17, he received a BSA from the University of Toronto in 1930 and a PhD in biochemistry in 1933. Early this year he was awarded an honorary Doctor of Science by the University of Guelph. In 1933 he came to California as a postdoctoral fellow at Berkeley, then went to Davis as a faculty member for eight years. From 1942 to 1963 he was director of nutrition and physiology research and director of biochemistry for Lederle Laboratories in New York state, where he worked on vitamins, antibiotics and anticancer drugs. He spent a year as a senior research fellow at Princeton University and then returned to California in 1963. He became associate director of the U.C. Space Sciences Laboratory, and was a co[illegible]ant to NASA in 1969-70. He is a member of many scientific, professional and honorary societies and editorial boards.

Dr. Jukes became deeply interested in DDT when "Silent Spring" first appeared because the book omitted any mention of the life-saving effects of DDT in malarious countries. He says, "I realized that DDT had done far more for human beings than all the research in nutrition. I also realized that we were confronted with the successful use of the "Big Lie" in science for the first time." Since then he has made continual active efforts to "get the facts out" in the current debate on technology and the environment. He is an ardent supporter of the American free enterprise system, modern agriculture, and above all, scientific truth.

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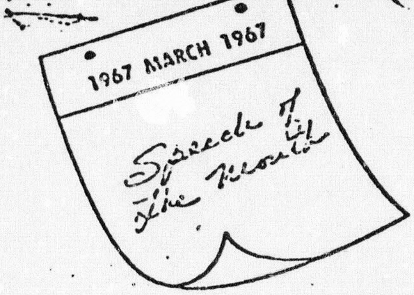

An Englishman by birth, Dr. Thomas H. Jukes received his B.S.A. and Ph.D. in biochemistry from University of Illinois and was a National Research Council Fellow in Medical Sciences at University of California, Berkeley. After serving on the faculty of College of Agriculture, University of California, Davis, he joined American Cyanamid Co.'s Lederle Laboratories Division in 1942 and from 1959 to 1963 served as Director of Biochemistry for Cyanamid's Agricultural Division. In 1963 he became professor-in-residence, medical physics and research biochemist at University of California, Berkeley. Excerpts from his talk before the Pacific Branch of Entomological Society of America in June are presented here.

The TRUE facts about Pesticides and the Environment

An eminent scientist reveals some startling statistics on bird counts and some revealing comments on the financial motives of pesticide critics.

By DR. THOMAS H. JUKES

I regard robins with more than usual interest for several reasons. First, I know they are not robins, but thrushes. As a child in England I was interested in birds and I often watched song thrushes hunting on the lawn for worms in a manner which resembles closely the feeding habits of the American robin, a bird who greets us in our gardens and also in the remotest meadow of the High Sierra. The robin has been a central character in the mythology of pesticides.

Perhaps the most startling announcement in this regard was the statement by Rachel Carson in *Silent Spring* that:

> "Like the robin, another American bird seems to be on the verge of extinction."

More of the other bird (the eagle) later, but note that the robin is said to be "on the verge of extinction", due, according to Rachel Carson, to the spraying of elm trees.

The theme was taken up by laymen and experts. Mr. Van Fleet, representing presumably the bird lovers, wrote an article for the *Atlantic Monthly* stating that robins had largely disappeared from the Pacific Coast due to the death of their young from eating earthworms containing DDT. He said:

> "If the merchants of death have their way, we will soon have no birds at all to sing over the graves of our hero dead, no birds to fill the spring woods with their chatter and gaiety, and our land will be desolate and silent as a shroud."

We have a suggestion for Mr. Van Fleet: Fresno County, California, is one of the largest users of pesticides, and its population of starlings has increased from none in 1942 to 8 million in 1962. Why not move Arlington National Cemetery to Fresno?

Rudd stated, "There is no doubt in my mind that millions of birds have been killed by DDT sprays on elm trees." The phrase "in my mind" is a welcome inclusion in this statement. Extrapolation is a favorable device of ecologists. For example, Wurster and co-workers (1955) make the following statement:

> "Since the study areas represented 24% of the sprayed part of town, and the May 1 resident population on these areas averaged 12 Robins, the total Hanover Robin population was approximately 500 to 550. Based on a 70% decline in the study areas by June 1, total Robin mortality in Hanover was about 350 to 400 birds."

However, Wurster and co-workers do not have the temerity to parlay 70% of 12 robins into several million by a "Rudd extrapolation."

In *Pesticides and the Living Landscape*, Rudd devotes several pages to describing the death of robins from the spraying of elms on the campuses of the University of Illinois and Michigan State University. He presents data showing that earth-

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[illegible] under elm trees sprayed with DDT contained from 33 to 164 ppm of DDT, and he states that a diet of 100 earthworms could contain more than 3 mg of DDT, a lethal dose to a robin. In contrast to this, a report from the University of Wisconsin described an experiment in which robins were fed 30 days on a diet of earthworms containing 26 ppm of DDT without any effect.

Rudd does not mention the Wisconsin report.

The scarcity of robins in the gardens of homes on the Pacific Slope was stated by Dr. Edward Swift in 1963 to be due to a good food supply in the foothill canyons so that the wintering flocks of robins stayed away from the cities.

Is the robin on the verge of extinction? In 1960, David H. Janzen, Director, Bureau of Sport Fish and Wildlife, U.S. Department of the Interior, classified the robin as being a member of a group containing "only a few species of birds that have food and roosting habits that conflict seriously with agricultural and urban life." He included robins as one of the birds that "most often draw complaints from farmers because of serious depredations on crops."

However, he wrote these words two years before the publication of *Silent Spring*. Perhaps the robins gallantly committed hara-kiri to substantiate the statement by Miss Carson. If so, the message had not been received by Roger Tory Peterson, one of the greatest living ornithologists and identifiers of birds, in 1963. Peterson stated:

> "What is North America's number one bird? Is it the house sparrow, introduced from England? Almost certainly not; the starling, less restricted to cities and farms, now outnumbers it. The American robin, however, is a more likely candidate than either. Found from coast to coast, it inhabits cities and forests alike and is one of the most abundant birds in the vast, 3,000-mile belt of conifers stretching across Canada to Alaska."

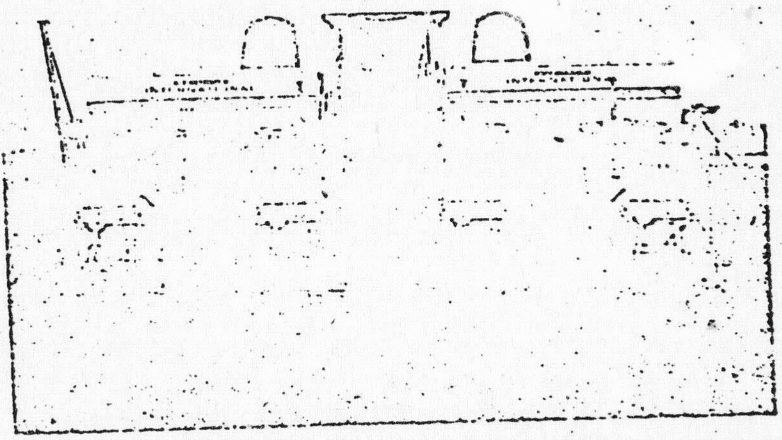
Newspapers in the Oakland, Calif. area during the past two winters have reported the slaughter of robins which were devouring pyracantha berries growing by the side of the freeways. The robins were being mowed down by automobiles.

THE EAGLE

Few national symbols are as cherished as the bald eagle. His majestic pattern of flight, his famous powers of vision, his imposing size and solitary habits have won a place in our hearts. Yet comparatively few people have seen a bald eagle, and he is more familiar in effigy on the President's Seal than as a living bird.

The fate of the bald eagle at the hands of Americans has been tragic. He has been incessantly hunted, even from single-engined planes. For many years there was a bounty placed on his head in Alaska, presumably because he liked to eat salmon. Thousands of eagles were gunned down for a few dollars per head. This degrading incident was not mentioned when a Marin county, California rancher was put on trial in 1965 for killing an eagle that was eating one of his lambs.

The stirrings of conscience have recently been aroused in the public by the disappearance of the bald eagle. Spokesmen for conservation organizations have directed an attack in recent years primarily against DDT, which is said to be respon-



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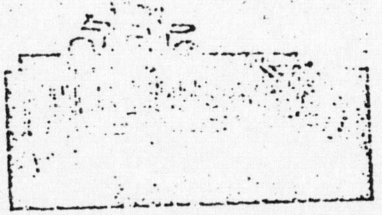

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sible for the failure of the egg eagles to hatch.

There are, of course, many factors that decrease hatchability of eggs, including disturbances of nesting sites by ornithologists. DDT is not highly active against hatchability; for example, DeWitt reported 80% hatchability in quail receiving 200 ppm of DDT in the diet as compared with a control group with a hatchability of 84%. He concluded that fertility, hatchability, and chick viability were unaffected.

A survey of dead eagles made by Sprunt in 1962 indicated that of 118 found dead, 77% were killed by gunfire, 7% were caught in traps, and 7% suffered death from other violent causes.

The encroachments of civilization generally lead to a diminution of the numbers of large predatory birds and mammals; disturbances of habitat adversely affect these species to a greater extent than their prey. It is not logical to single out DDT as being a primary factor in the disappearance of the bald eagle.

Even exceeding the eagle in size of wing spread, powers of flight, and rarity, is the California condor. Again, chemical poisoning has been mentioned recently as playing a part in bringing this species near to extinction.

I have been much interested in comparing the fortunes of the condor with those of a similar species, the common and ubiquitous turkey vulture, who has apparently adjusted himself to living with human beings and is a familiar sight throughout the countryside. Just why turkey vultures do not appear to suffer from chemical poisoning has not been explained, although their habit of vomiting has been mentioned as a possible safeguard.

However, in the case of the condor it is indeed interesting to note the remarks made by William Dawson in his monumental work, *The Birds of California*. This eminent ornithologist stated in 1923 that there were unquestionably fewer than 100 condors alive in California and that the number was probably not more than 40. The virtual disappearance of the condor, therefore, took place prior to the introduction of organic pesticides. Dawson also states that the primary cause of the disappearance was gun-fire, the second cause was "science, as exemplified by bird stuffers and egg collectors," and the third was that civilization abolishes carrion which is the condor's food. Dawson speaks of poisoning in the following terms:

> "This sounds very plausible but I am not persuaded. Evidence is lacking to show that the vultures would die of poisoning. The coyotes ate the poisoned carcasses and were killed. If the condors were killed they must have fallen in their tracks or at least in the open but there is no record of such destruction."

A survey of the condors in California in the fall of 1966 gave a minimum of 51 birds seen in a two-day count. This is within Dawson's 1923 estimate. If so, there is no evidence for an effect of organic pesticides on the condor population.

My impression is that the numbers of birds are tending to increase in part due to suppression of vectors of avian diseases by pesticides, but there is, and will continue to be, a shift in species. The birds that are adaptable, such as starlings and blackbirds, to life on farms, will crowd out some of the species that are more esthetically attractive, examples of which are bluebirds and flycatchers.

It seems obvious that pesticides

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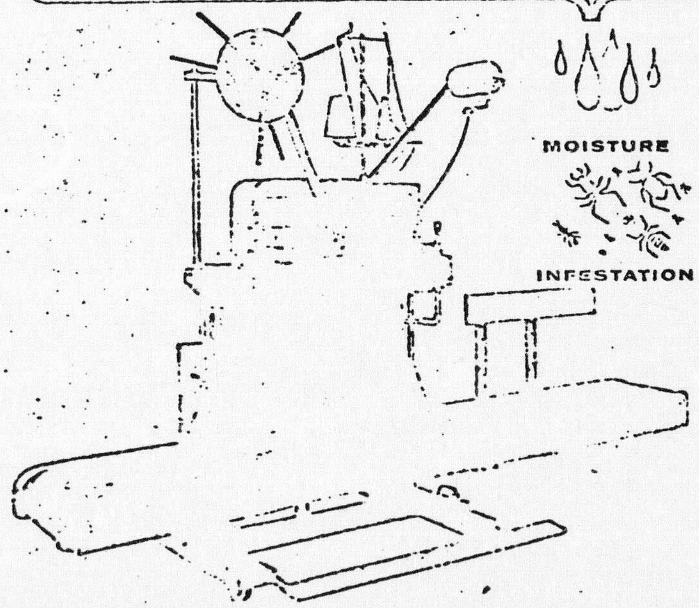

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are not having an overall deleterious effect on wild birds. For example, huge numbers of starlings have taken possession of areas of California where intensive farming is practiced and where pesticides are used on a large scale.

WHO REALLY PROFITED?

The critics of pesticides have usually attributed financial motives to those who advocate the use of these chemicals. For example, it is stated in *Silent Spring*:

> "This situation also explains the otherwise mystifying fact that certain outstanding entomologists are among the leading advocates of chemical control. Inquiry into the background of some of these men reveals that their entire research program is supported by the chemical industry. Their professional prestige, sometimes their very jobs depend on the perpetuation of chemical methods. Can we then expect them to bite the hand that literally feeds them? But *knowing their bias*, how much credence can we give to their protests that insecticides are harmless?" (Author's italics)

Miss Carson has also said:

> "More than one scientist has raised a disturbing question—whether a spirit of Lysenkoism may be developing in America today—the philosophy that perverted and destroyed the science of genetics in Russia and even infiltrated all of that nation's agricultural sciences. But here the tailoring, the screening of basic truth, is done, not to suit a party line, but to accommodate to the short-term gain, to serve the gods of profit and production."

These are very serious charges. They are made with a callous disregard of the efforts by scientists to fight hunger and disease. These efforts are channeled through the free enterprise system, because that is the system under which this country operates. Excesses that take place under the free enterprise system are correctable by public debate and the enactment of legislation. To talk of "screening of basic truth" in this country in the same context with Lysenkoism, under which geneticists were sent to die in Siberia, is fantastic nonsense. The text of *Silent Spring* needs screening to amend wild statements about cancer, robins, pheasants, and quail.

On the Berkeley campus, the Free Speech Movement, now known as the Vietnam Day Committee, has joined in the chorus. In a pamphlet, "The Regerts," Carson has stated:

> "Even worse than censorship is deliberate press agentry on behalf of a special interest. University officials in the Division of Agriculture Sciences have joined chemical industry spokesmen in a campaign against the President's Scientific Advisory Committee on Agricultural Chemicals and Rachel Carson's book, *The Silent Spring*. . . .
>
> "The chemical industry uses the University as a research and development laboratory for pesticides."

I have come in for my own share of these comments. For example, in the *Sierra Club Bulletin* it was stated:

> "In late 1963, *American Scientist* (Society of the Sigma Xi) published a pesticide paper by nutritionist and biochemist Thomas H. Jukes. The editors were so heavily criticized for running this type of pesticide article that they decided to publish another paper presenting a broad ecosystemic and sociologic approach."

The statement was made by Frank Egler in attacking a letter by Dr. Leslie Wynston which praised me. Egler told the editors of the *Sierra Club Bulletin* that they had "chosen to let a scientist (himself), be damned in the eyes of their readers." (This was his reaction ~~in~~ to mild criticism). Four letters criticizing my article were received by the *American Scientist*. Two of these were written by professional conservationists. I also received a flood of requests for reprints; some asked for as many as 100 reprints to be used in teaching. However, the point of this is that when I wrote to comment on Egler's letter, and to set the record straight about myself, the editor of the *Sierra Club Bulletin* refused to publish my letter.

Since the issue of monetary interest has been raised, let us examine the financial rewards made by those opposing pesticides.

It is quite obvious that the Houghton Mifflin Co. must have made a handsome profit on *Silent Spring*. At least one member of this organization has used the book for prestige purposes; Paul Brooks of this company, listed himself as "publisher of *Silent Spring*" in his statement of qualifications as a candidate for the Board of Directors of the Sierra Club.

The Sierra Club itself, through the writings of its Executive Director, David Brower, has vigorously attacked the use of pesticides. The relationship between pesticides and the exploration of the Sierra Nevada is not clear. However, Brower stated "the nation's leading conservation organizations support the Rachel Carson thesis. A leader among them is the Sierra Club." He could have added—"and *we accept her money*." for the Sierra Club was willed half of Miss Carson's estate, including the royalties from *Silent Spring*.

The National Audubon Society must undoubtedly have benefited financially from the current campaign against pesticides by gaining new members and donations. I have no information on the extent of these benefits, but the stimulation of interest in bird life by the general public that has been occasioned by the campaign against pesticides is obviously very great.

Large sums of money in the form of research grants will inevitably accrue to various governmental and academic groups through the pesticide controversy. This will be especially true of agencies which are concerned with fish and wildlife. One does not need to raise the question of financial interest; obviously an administrator would be derelict in his duties if he failed to take advantage of the availability of research funds in his own field. Dr. Buckley, of U.S. Fish and Wildlife Service, in a nationwide television broadcast, exhibited the stuffed carcass of a pheasant which he said had suffered a change in color as a result of receiving insecticides. Actually, the bird had been specially treated with a seldom-used estrogenic hydrocarbon, but the public impression was not erased.

Dr. David Janzen, Director, U.S. Sport Fishes and Wildlife, showed evidence that he is concerned with both the protection of birds and a bird depredation and control program. Lethal agents are being investigated for the latter purpose, and oddly enough, we can be sure that simultaneously the Bureau will greatly expand its program in the direction of examining the toxic effects of pesticide residues on wild life.

PESTICIDES AND THE POPULATION EXPLOSION

Probably pesticides did more to bring about the population explosion than any other cause except one. Part of this has been documented in the book *DDT and Its Significance*, edited by Paul Müller, in chapter 7, written by Samuel W. Simmons (1959). Some information from Dr. Simmons' article is shown in the three tables below. He has commented that the use of DDT, which reduced malaria, also improved human social conditions. This inevitably means an increase in the birth rate. Pesticides, which accelerated the population explosion, were then called upon to aid in the production of food for the new millions. I do not know of any other sociological phenomenon that is comparable to the dual role of pesticides.

The need for more food must be met by drastic increases in the use of synthetic fertilizers. The need for pesticides can be directly equated with the need for more fertilization if food production is to reach the yields made possible by utilization of the potential of the land. ☆

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Statement by Thomas H. Jukes at Seattle hearings on DDT, October 15, 1969

My name is Thomas Jukes. My training is in biological chemistry and I received a Ph. D. degree at the University of Toronto in 1933. I was on the faculty of the University of California from 1934 to 1942 in the College of Agriculture. My work there was on the discovery and identification of vitamins. I went to Lederle Laboratories, a division of American Cyanamid Company, in 1942, where I directed research on vitamins, antibiotics and anti-cancer drugs. The action of a group of drugs, the anti-folic compounds, was discovered in my department. These are used in the treatment of leukemia and chorionic carcinoma. The work of our group was recognized by two Borden Awards and a Mead Johnson Award.

I became interested in pesticides, although this field was not my job responsibility, because of the "cranberry incident" and the book SILENT SPRING, which I thoughtwas one-sided, inaccurate, and anti-intellectual My main scientific interest is in the genetic code and molecular evolution. In 1963, I resigned from American Cyanamid Company to be a professor at the University of California, Berkeley, where I am Associate Director of the Space Sciences Laboratory. I have no financial interest in DDT.

In 1962, I read Dr. Hayes and Dr. Simmons' book in DDT. This was exciting and alarming. It showed that the lid had been taken off the population explosion. We are now told by the Environmental Defense Fund that this was all very fine, but it is ancient history and other pesticides can replace DDT for malaria control. The WHO knowsbetter, and tells a different story.

Truly, the question of DDT can be considered only on a world-wide basis. Not only is DDT detectable in parts per billion, but as Dr. S. W. Simmons said (USPHS):

> *"The total value of DDT to mankind is inestimable, and is comprised of health, economic and social benefits."*

He lists the health benefits as control of insect-borne diseases such as malaria, typhus, and of insect pests; as use in agriculture for increasing the food supply and thus overcoming malnutrition; and as increase in resistance to non-insect borne diseases such as dysentery. Control of malaria has resulted in increased economic status. Simmons also says:

Defendant N.Y. Times Exhibit Q

> *"Most of the peoples of the globe have received some measure of benefit from DDT. Except for antibiotics, it is doubtful that any material has been found which protects more people over a larger area than does DDT."*

We heard yesterday, and we have heard repeatedly, that DDT is no longer needed, that its place can be taken by other insecticides, or by biological control.

I will quote from a statement by the head of malaria eradication for the Pan American branch of the WHO:

> *"The withdrawal of DDT would mean the interruption of most malaria eradication programs throughout the world.*
>
> *DDT has been the main weapon in the world-wide malaria eradication program. Research has continued for the development of other methods of attack against malaria and for the development of alternative insecticides. To date, there is no insecticide that could effectively replace DDT which would permit the continuation of the eradication program or maintain the conquests made so far.*
>
> *The withdrawal of DDT will therefore represent a regression to a malaria situation similar to that in 1945. The reestablishment of malaria endemicity would be probably attained following a period of large scale outbreaks and epidemics which would be accompanied by high morbidity and mortality due to loss of immunity by population previously protected by eradication programs.*
>
> *The use of DDT in malaria eradication, i. e., by the spraying of the inner surfaces of houses, has little opportunity of contaminating the environment and bringing any considerable amount of DDT into the food chain.*
>
> *Toxicological observation of spraymen working for a number of years in malaria eradication and even in formulation plants, has not revealed toxic manifestations in them. Neither has there been any evidence of toxicologic manifestations in people residing in houses that have been repeatedly sprayed at six month intervals.*
>
> *We therefore believe that a great harm will result from the unqualified withdrawal of DDT. We feel that selective use of DDT is justified and warranted."*.

The WHO tested 1,300 insecticides before coming to this conclusion. The WHO has also tried biological control, and reports it to be a promising line of research which "may have a great future, but up to now, there are no techniques that could be used in large scale malaria eradication campaigns." I know of no-one who is opposed to biological control - I certainly am not, but biological control has not yet reached the point where it can replace pesticides for general use in food production.

Russell (P. F. Russell, Bull. N. Y. Acad. Med., 44:623, 1968)estimates that the appropriations of the U.S.A. for overseas malaria control and eradication were a half-billion dollars in the past 25 years. As a result of international cooperation, WHO has had a world-wide malaria eradication program so that:

> *"To-day more than 960 million people who a few years ago were subject to malaria endemicity are now free of malaria; another 288 million live in areas where the disease is being vigorously attacked and trasmission is coming to an end. Because much of Africa remains highly malarious and because about 288 million people live in malarious areas not yet subject to eradication measures, it is logical that the United States should maintain an active interest in this disease."*

Russell reminds us that malaria was endemic throughout the U.S.A. 100 years ago, "even spilling over into Canada" and was the commonest endemic disease in many localities. Malaria was eradicated from the U.S.A. during 1948 to 1952 by a DDT spraying program.

The EDF speaks of the use of DDT in combating malaria as "glamorous". Actually, of course, fighting malaria is hard, uncomfortable, dangerous work by dedicated, uncomplaining people in the steaming swamps of the tropics.

The second issue has been defined by Dr. Wurster in BioScience and elsewhere. It is to take control of pesticides away from agriculture, and put it in the hands of what he calls "environmentalists" - presumably he means the EDF. His words are:

> *"If the environmentalists win on DDT, they will achieve, and probably retain in other environmental issues, a level of authority they have never had before. In a sense, then, much more is at stake than DDT."*

This would enable a group which has consistently shown no interest in the food supply, which opposes the use of pesticides and prefers biological control, and which has no expertise in the complexities of modern agricultural technology, to have authority over pesticides. Some predictable results would be that the food supply would be cut in half and that far more labor would be needed on the farms.

The environmentalists, as they call themselves, have not shown sufficient involvement in basic human needs: the need for food, the need for protection against infectious diseases, to be entrusted with the responsibility of controlling pesticides. The environmentalists make airy statements about non-persistent pesticides immediately and completely replacing the chlorinated hydrocarbons. These statements are in conflict with the findings of the WHO.

The third issue is the continued use of all the chlorinated hydrocarbon insecticides. The EDF wants all these banned, although the current attack is on DDT. The National Academy of Sciences issued a 1969 report on persistent pesticides, which include the chlorinated hydrocarbons. The conclusions include the following:

1. Persistent pesticides are contributing to the health, food supply and comfort of mankind, but, in the absence of adequate information on their behavior in nature, prudence dictates that such long-lived chemicals should not be needlessly released into the biosphere.
2. Although persistent pesticides have been replaced in some uses and are replaceable in others, they are at present essential in certain situations.

Benzene hexachloride (BHC, gammexane, lindane) and DDT are both in this group. BHC is of prime importance to India and other rice-growing nations in the control of the rice stem borer. BHC has been reported to increase rice yields in experimental plots by more than one ton per acre, according to the International Rice Research Institute. The new high-producing strains of rice developed by the Rockefeller Foundation are dependent at present on BHC. Communist China announced a few years ago that its two principal chemical pesticides were DDT and BHC. A photograph was published showing BHC being poured into city sewers for mosquito control. It was stated that 60 lbs. of pesticides were applied per acre of cultivated land in mainland China.

The next issue is the future use of all pesticides, persistent and non-persistent. The EDF in 1968 filed suit to prevent the use of malathion and Abate for mosquito control on Long Island. Many non-persistent pesticides are hazardous to apply, and because they are non-persistent, they must be used far more frequently than the chlorinated hydrocarbons. It is quite easy to show that the major non-persistent pesticides produce enzyme changes in man. The industrial and medical accidents caused by the new organic pesticides are predominantly due to the non-persistent type, especially parathion. Nicotine sulfate, advocated by the Audubon Society, is at least 500 times as toxic as DDT.

The fifth point at issue is the ethics of scientific discussion. The anti-DDT group regard themselves as dedicated to obtaining a ban rather than to reviewing pros and cons. They praise the methods used by a prosecuting attorney. Their lawyer was warned by the hearing examiner in Madison against histrionics and badgering witnesses. Some scientists respond well to such methods, others retreat into their shells. It is quite easy to get a witness to admit that DDT is poisonous. He can then be browbeaten into admitting that he favors poisoning the public, if the lawyer is sufficiently unscrupulous. There are other indications of anti-intellectualism, in the campaign against DDT. I quote from a speech by Dr. Paul Ehrlich of Stanford University:

> *"Tests conducted by a pesticide manufacturer are like putting the fox in charge of designing the lock on the henhouse door."*

(Note that the information on the production of cancer in rats by aminotriazole was furnished to the FDA by American Cyanamid Company).

> *"The petrochemical industry is putting out lies about the effects of pesticides."* also *"the USDA is a subsidiary of the petrochemical industry."*
>
> *"It's conceivable we've already knocked 10 years off the life of every kid born since 1945."*

This kind of talk is reminiscent of the ravings of T. D. Lysenko, who said that "when different birds are fed hairy caterpillars, cuckoos hatch from their eggs."

The successful resolution of a scientific question depends on bringing both sides into the open. For example, the EDF failed to mention at Madison the findings that DDT produced thickening of the eggshells of Bengalese finches, although the EDF knew of this.

The next point at issue is the effect of this vitriolic campaign on the attitude of other countries towards DDT. Here is where the human casualties may reach enormous proportions. Interruption of the DDT supply to Ceylon in 1964 was followed by a rapid increase in malaria. Condemnation and banning of DDT by the U.S.A. would, in the opinion of the WHO, lead to objections to its use in tropical countries. Obviously it would be said that DDT is a poison which the Americans will not use on themselves. And the WHO has repeatedly declared that substitutes for DDT in the malaria eradication program are not available.

My final point is the relation of DDT to something that is as old as humanity itself - man's upward struggle towards freedom of the spirit. Disease and hunger debase man. Through countless centuries, he has been scourged by parasites and insects that attacked him and his crops. Only a hundred years ago, Edwin Markham asked in "The Man With The Hoe" who the "rulers in all lands" could answer the rage of peasant who labored to make a bare living by scratching the soil. The answer was swift in coming; not from the rulers, but from scientists, who lifted the burden of labor from the farm. We must not push man back into his old dungeon. His number are increasing too fast. Several people, including a Wisconsin legislator have said in print that DDT should be banned in order to slow down the increase in population. In my opinion, starvation and disease are not the way to control population.

The Delaney clause in the Food Additives Amendment says that if a food additive causes cancer, the tolerance for it is zero. On the face of it, there can be no valid objection to such a provision. Arguing against it puts one in the position of seeming to be in favor of cancer. However, this regulation has presented all sorts of difficulties ever since it has been enacted.

First, there are many substances naturally present in foods that can be shown to produce cancer in experimental animals, such as cholesterol and sex hormones in all meat and fish, and aflatoxin in peanuts.

Second, various types of processing produce cancer-causing substances in foods. Barbecuing meat is an excellent example, also roasting coffee.

Third, zero content can never be reached, and new analytical methods always show the presence of contaminants that were unsuspected.

Fourth, cancer-causing is defined in terms of experimental animals, and concern is for human beings, which may be either more or less susceptible than the animal to the action of a given substance.

In the case of DDT, I think that the best study is the one in the Montrose plant, because the dosage was so high, and I don't think we are ever going to get as good a test for any other pesticide, because we are never going to get a group of volunteers to take in 400 times the average dosage of a pesticide every working day for up to 19 years.

The WHO should be able to furnish us with epidemiological evidence on the occurrence of cancer in populations with prolonged exposure to DDT, since they state that 535 million people and 130,000 pest control operators have been exposed to DDT without harmful results.

The charge that DDT causes cancer is an old one, and has not yet been substantiated. It has been made by most opponents of pesticides. Often they throw in other diseases for good measure. For example, in 1951, before a Congressional Committee:

> *Louis Bromfield, novelist and gentleman farmer, testified that virus X, the mysterious, influenza-like epidemic disease, may be nothing more than manifestations of DDT poisoning; and the increase incidence of heart disease, cancer and leukemia may result from cumulative poisoning by pesticide residues.*

Such statements always get public attention. Indeed, this is the keynote of the anti-DDT campaign - get public attention! Distribute bumper stickers with a skull and crossbones! Sell posters with a picture of pregnant woman! Get newspaper cartoonists to help!

I have the impression that the EDF tries various approaches to see how well they catch on. Van den Bosch in September compared DDT with thalidomide. He suggested that DDT was a global thalidomide which was harmless to the mother but maimed the fetus, and that he was against DDT for moral reasons. This didn't make the newspapers. In October, the emphasis is on cancer rather than deformities. Mother's milk is always good for headlines, and the combination of mother's milk and cancer is sure-fire.

It is pertinent to review the background of the presence of DDT in both cows and human milk. The FDA, years ago, said that cows' milk was a special food because it is regularly fed to sick persons, the aged, and infants, and therefore, no additives were permissible, except vitamin D, and no contaminants were allowed. The tolerance was zero.

This praiseworthy attitude, with its satisfying psychological basis, was jolted by the development of new analytical methods, as a result of which farmers were frequently made to dump many gallons of milk because of the presence of traces of DDT, penicillin, etc. It was then found that the entire evaporated milk supply of the USA contained DDT. The levels present were far below the 7 ppm tolerance for other foods. A tolerance was then set for milk at .05 ppm. Since cows are vegetarians, this extremely low tolerance could be met by meticulous attention to their diet. It had been earlier found, in 1950, that human milk in Washington, D. C., contained DDT ranging from 0 to 0.77 ppm, averaging 0.13 ppm. Another investigation, in 1965, reported a range of 0 to 0.13 ppm, averaging 0.08.

The authors, Quinby Armstrong and Durham, in Wenatchee, noted that the DDT content of both human and cows' milk was trending downwards, and also that women excreted a much larger fraction of their daily DDT intake in their milk than cows did.

The tolerance of .05 ppm in cows' milk reflected the thinking that babies may be more susceptible than adults to DDT, a thought which persisted despite a statement by the American Medical Association to the effect that bottle-fed babies are, nowadays, put on a diet containing other foods when they are very young, and these foods often include processed baby foods for which finite limits for content of pesticide residues have been set.

In my opinion, a conservative attitude for milk is to be commended, but in this case the ratio between the amount permitted in milk as compared with other foods was set at more than 1:100, which was scarcely realistic. A ratio of 1:10 would have been more sensible. The .05 ppm figure said, in effect, that the amount permitted in milk was one ten-thousandth of the toxic dose. As far as I know, no substance present in foods, natural or added, could meet such a requirement; not even water. It was this anomaly that led to the uproar about human milk.

The tolerance of 7 ppm in adult foods may be compared with the finding that rats on a diet containing 200 ppm of DDT reproduced normally through three generations (Ottoboni, 1969). Results with human beings indicate that adults can consume 15 to 18 milligrams of DDT daily for periods up to several years without showing detectable ill effects. If we arbitrarily assume that the amount tolerated by infants should be not more than one-tenth of this level, then an eight-pound baby could safely receive about 0.1 mg daily. This would be present in one quart of breast milk containing twice the level of DDT that is permitted in cows' milk. However, it must be borne in mind that the figure of 15 to 18 milligrams of DDT daily for adults does not represent the highest level that is non-injurious.

The concept that milk is normally free from so-called toxic substances is an illusion that does not fit the facts of science. Toxicity depends on quantity, not identity. Milk contains nicotine if the mother has been smoking. Nicotine is about 500 times as poisonous as DDT. Milk always contains arsenic and radioactive carbon. Milk contains cholesterol, which is carcinogenic to experimental animals under appropriate experimental conditions.

Human milk has great symbolic and emotional significance, recognized by artists and authors, ranging from Peter Paul Rubens to James Joyce. Interest in the DDT content of human milk was heightened when during the DDT hearings a scientist dramatically flew from Sweden to Wisconsin to announce that he had found DDT in human milk. The mass media responded to this piece of showmanship with great intensity. Posters have appeared in the San Francisco area showing the naked breasts of a pregnant woman, coupled with an appeal to fight DDT. Among the implications drawn in the newspapers was the allegation that because baby rats are more susceptible than adults to certain poisons, the same holds for DDT. Strangely enough, very young animals seem less susceptible than older ones to DDT in various experiments which include rats (Ottoboni, 1969) and quail (DeWitt, 1955, 1956). In the latter case, young quail hatched normally from eggs laid by mothers on a diet containing 200 ppm of DDT, but the young birds had a mortality of between 80% and 90% during the first twelve weeks of life.

It is instructive to compare the effects of the presence and absence of DDT on the health of babies. In the USA, encephalitis is a crippling disease of infants which is caused by mosquitoes. About 25 years ago, the main cause of infant mortality in India was malaria (Burnet, 1953). This has been almost eliminated by the use of DDT. The intake of DDT in India, in one investigation reported by Hayes (1967), is 20 times as high as in the USA. I have no figures on DDT in breast milk in India, but the 20-fold figure would indicate that infants might be receiving as much as 2 mg of DDT daily from their mother's milk. During the period 1953 to 1962, life expectancy in India rose from 32 to 47 years, principally as a result of DDT (Pal, 1962).

The discussion yesterday was simplified as follows: DDT is indestructible; DDT is everywhere. It doesn't matter how small the amount is, because it always becomes concentrated to reach harmful levels. DDT causes cancer, embryo mortality and destroys the nervous system. If it doesn't kill a species now, it will in 5 or 10 years.

However, there are one or two points that seem to have been skipped. DDT is destroyed by ultraviolet light which breaks it into open-chain compounds. The use of DDT is steadily decreasing and so are the amounts in foods and in human tissues in the U.S.A.

This decrease is taking place without a ban. DDT should be retained for its essential uses until it can be replaced by something as good or better.

TOXICOLOGY

An essential point in all discussions of toxicology is the concept of quantity. It seems extraordinary to have to mention this elementary matter. However, the EDF, at its convenience, frequently ignores it, or omits it, and this serves to confuse the public. For example, the presence of DDT in Antarctic penguins is often brought up without mention of the fact that the amounts found were a fraction of a part per million, and most samples tested zero. Penguins are at the end of a food-chain, of course, so there is no subsequent biological magnification. Mellanby has calculated the total amount of DDT in all the penguins in the Antarctic, based on the amounts detected in positive samples so far. It comes to 250 grams for the entire biomass of 10 million penguins. This is presumably an overestimate, because most samples test negative. He suggests that the DDT comes from garbage and sewage originating from Antarctic expeditions, naval vessels, weather stations, etc.

If one gallon of water were mixed with all the water in the biosphere, each gallon of water in the world would contain 60,000 molecules from the original gallon. It is well known that human beings are contaminated, if you wish to use the word, with all kinds of substances that are poisonous at high concentrations. Traces of some of these "poisons" are actually essential to life, such as copper, selenium and zinc. Without quantitation, any discussion of poisons is confused and meaningless. DDT is everywhere, so it is convenient to blame it for everything. The types of statement made about the universal presence of DDT can be applied to all the pesticides, including the so-called "soft" pesticides because their breakdown, although rapid, is never complete within finite time.

All discussions of toxicity, including carcinogenicity, are meaningless without reference to the dose-response curve. I remember, as no doubt many of you in Washington do, the "cranberry fiasco" of 1959, when Mr. Flemming, Secretary of Health, Education and Welfare, terrified the public by telling them that cranberries containing traces of the weedkiller aminotriazole could give them cancer. The information on cancer was supplied to him by American Cyanamid Co., who had found that rats on high levels of aminotriazole (but not at low levels) developed thyroid tumors. Exactly the same condition of the thyroid can be developed by feeding a diet without iodine and for the same reason, which is a compensatory growth of the gland to overcome the inhibition of its production of thyroxine. To produce the effect, it would have been necessary to eat several hundred pounds of cranberries a day. Furthermore, aminotriazole was being used for the clinical treatment of overactive thyroids. Anti-thyroid compounds that act similarly to aminotriazole are naturally present in cabbage, turnips and many other vegetables. Yet we never really caught up with the panic that Mr. Flemming started. With the help of TV, bumper stickers, a prosecuting attorney, a nursing mother, Dr. Risebrough, Dr. Chant, and movie actors, he might have been even more effective

DDT, phenobarbital, and other substances induce the production of microsomal enzymes by the liver. These enzymes hydroxylate or dealkylate the substances that induce their formation, and other substances, including steroid sex hormones, and the highly potent carcinogen, aflatoxin, which produced cancer at levels of 0.03 to 0.08 ppm of diet in studies with ducks and trout. Aflatoxin occurs in peanuts which have become moldy. The toxicity of aflatoxin is reversed by dosing with DDT, and McLean and McLean found that phenobarbital protected rats against the carcinogenic action of aflatoxin. The effect of DDT is detoxifying aflatoxin is of great interest in view of the extensive use of peanuts and their products in the human diet.

A third factor that is often ignored by the EDF is metabolism and storage. There have been at least five studies of storage of DDT in human body fat in relation to dosage. The results all fall on the same line in a graph over a wide range. DDT dosage of 1 mg per man per day, for example, will equilibrate the body fat level at about 11 ppm. If the dosage is reduced to 0.1 mg per day, the body fat level drops back to 4 ppm, because there is an equilibrium between storage in the fat and excretion of breakdown products, such as DDA and DDE, in the urine.

Hayes (1967) stated:

> *"compounds which are absorbed tend to reach a steady state of storage and for each compound the storage at equilibrium corresponds to dosage. People not trained in the biological sciences are usually unfamiliar with these facts and suppose that compounds are of two distinct sorts, those that are stored and those that are not. They suppose that compounds that are stored at all continue to accumulate indefinitely with no tendency to reach a steady state in which the amount lost each day is equal to the amount absorbed. It may seem odd to mention this folklore.. but the views of the public are a most important factor, which must be taken into account in any long-term effort to achieve general public acceptance of a particular usage or course of action."*

A procedure that has been used throughout the campaign against pesticides is to represent that they are inherently bad because they are a product of the capitalist, or free enterprise, system. Pesticides are said to be sold by high-pressure methods to make money rather than to serve the public. One of the first crusaders, Mrs. Laura Tallian of California, used the headline in 1959 "Stop Poisoning for Profit". This theme has been taken up, or imitated by Rachel Carson, the National Audubon Society, the Environmental Defense Fund, and many newspaper writers. As recent examples, Wurster stated in the Congressional Record, May 5, 1969, that "The propagandists with vested interest try to tell us that the food and fiber for a starving world depend on the continued use of DDT", and the Madison, Wisconsin Capital Times, September 24, 1969, referred to "the pesticide industry with its economic muscle and well-oiled propaganda machine, defending its obsolete product with the feebie passion of the cigarette industry."

Such statements should be examined from various standpoints. First, the statements are arguments ad hominem instead of upon the subject being discussed.

This method of debate is, in my opinion, uncivilized. All who value their freedom should oppose it. Two of the EDF witnesses in Wisconsin (Loucks and Reeder) even used the method before the defenders of DDT had presented their case. They warned the public "to expect a snow job" by industry, thus seeking to discredit testimony before it was given. I remind you that such tactics often lead to court trials being declared invalid.

Second, the technique of smearing the opponent is usually a tacit admission of failure, or a cover-up for an errors and omissions. The statement by Wurster that I quoted omits the fact that the WHO says that the anti-malaria program will collapse without DDT. The Wisconsin newspaper compared the pesticide industry to the cigarette industry. About half of the people in the world would starve, or die, or both, without pesticides. In contrast, an end to the cigarette industry would have exactly the opposite effect - it would prolong human lives and, of course, increase the need for food.

Third, the use of pesticides is not linked to the capitalist system; for example, Communist China in 1958 boasted of using 60 pounds of pesticides per acre of cultivated land, and stated that the principal chemical pesticides used were benzene hexachloride and DDT.

Fourth, it has been evident from the beginning that a ban on DDT would increase the profits made by the chemical industry, because more costly pesticides would have to be used.

Finally, the campaign against pesticides has slowed down the search for new ones, because a number of chemical companies have withdrawn from this pesticides research as a "public relations headache" because of the clamor made by Rachel Carson and her followers.

By making the attack on pesticides an attack on industry, it is easily possible to arouse the public and to stimulate crusading newspaper reporters. As we have seen, and as we shall see here, the mass media becomes much more interested in the attack than in the defense. Flushed with publicity and confident that rebuttal will be unheard, the attackers often proceed to make extravagant statements; and take up a fixed position.

The present structure of society in the USA presents an agricultural problem of the first magnitude, because the urban population has become completely alienated from agriculture. One farmer now feeds 40 non-farmers. Thirty or forty years ago, many city dwellers were of rural origin, and understood something about farming. The present urban generation are children of the city. Many of them know nothing about pesticides beyond the diatribes they have read in Silent Spring or in the newspapers. They have not done the hard-work needed to fight insects and weeds on the farm, to produce food. Professor Carew of Michigan State University has told in simple language what happened:

> Soon it came to pass
> That certain well-fed members of
> Society
> Disapproved of the Farmer using
> Science.
> They spoke harshly of his techniques
> for feeding, protecting, and
> preserving plants and animals.
> They deplored his upsetting the
> Balance of Nature;
> They longed for the Good Old Days.
> And this had emotional appeal to the
> rest of Society.
> By this time Farmers had become so
> efficient, Society gave them a new
> title:
> Unimportant Minority.
> Because Society could not ever
> imagine a shortage of food
> Laws were passed abolishing
> Pesticides, Fertilizers, and Food
> Preservatives.
> Insects, Diseases, and Weeds
> flourished.
> Crops and animals died.
> Food became scarce.
> To survive, Industrialists, Artists and
> Doctors were forced to grow their
> own food.
> They were not very efficient.
> People and governments fought wars
> to gain more agricultural land.
> Millions of people were exterminated.
> The remaining few lived like animals.
> Feeding themselves on creatures and
> plants around them.
> And this was called IN BALANCE
> WITH NATURE.

A more sophisticated analysis was made by Sir Peter Medawar (Nature, 223:985 (1969)). He says: "We are oppressed by a fear of deterioration of the world through technical innovation. We tell ourselves that artifical fertilizers and pesticides are undermining our health; soil and sea are being poisoned by chemical and radioactive wastes . . . there is a sense of doubt about the adequacy of man, amounting in all to what a future historian might describe as a failure of nerve. There is a rootlessness about philosophical thinking as if the discovery or rediscovery of the insufficiency of reason had given paradoxical validity to nonsense." In other words, an obvious untruth is more palatable to some people than an uncertain truth.

One thing is certain: unless the public learns to reject anti-scientific propaganda for banning pesticides, we are headed for trouble in agriculture. The public cannot be expected to become toxicologists, which is said to be an easy field to master in two lessons, each four years long. Nevertheless, if questions involving toxicology are to be settled by public debate, it will be necessary for the public to acquaint themselves with some of the principles of toxicology. Seevers (1961) has pointed out, that if it is required that a chemical be without the possibility of human injury, man would be denied the use of every chemical substance, and no competent pharmacologist, toxicologist or clinician will undertake to guarantee that no risk is present in a chemical. He says" "The use of every chemical substance in man involves a calculated risk. The greater the benefit of a chemical substance to man, the greater justification for the increase in risk in its use." The public must learn that all human endeavors, including life itself, involve a risk, and the benefits of taking a step must be equated against the dangers.

We must expect that zealots and crusaders will do their best to prejudice such evaluations by inflammatory statements. Such statements must be challenged and exposed, for the human species will not find salvation in anti-intellectualism and the destruction of the scientific method.

If we fail to restore reason to the debate on pesticides, the public will face increased food prices, decreased food quality, decreased food supply and inadequate protection against insect-borne diseases.

ENZYMES

The induction of liver enzymes by DDT and DDE is viewed with great alarm by the EDF. But it is not a change in the amount of an enzyme that decides the physiology of an animal, it is the extent of the enzyme's action as measured by the metabolism of the living animal. The action of enzymes in animals is regulated by an elaborate series of checks and balances, including feedback mechanisms.

The headlines from Wisconsin said that DDT would make people sterile, and DDT has been claimed to have estrogenic properties. Many experiements with animals and with human subjects have shown no effect of DDT in reducing reproduction, even when administered at levels up to 200 ppm in the diet. These levels are far higher than those reported to cause enzyme induction. This statement applies to several species of birds, and to all mammals that have been tested, including man. Men are more susceptible than women to the effects of estrogens on secondary sexual characteristics. For example, men who are exposed to diethylstilbestrol in industrial operations have been found to have swelling of the breasts and loss of libido. The 35 men in the Montrose Chemical Co. factory who had taken in DDT for 9 to 19 years at levels averaging 400 times that of the general population became the fathers of 101 children during this period. An estrogen would have made these men impotent; instead, they contributed at above the average rate to the population explosion. Indeed, if DDT had even a moderate effect in reducing the human birthrate, this would have shown up beneficially for society in India, where 147 million pounds of DDT were applied, mostly to human dwelling places, in eight years. As a result, billions of mosquitoes were replaced by thousands of children, who were breast-fed, of course. Reproduction is measured by numbers of living young, not by liver enzymes. Many of the children are in a state of social ferment. Enzymes are also known as ferments. Perhaps this is the real connection between DDT and enzymes.

WILDLIFE - A State of Dynamic Change

The prevailing attitude towards wildlife is based on emotion rather than logic, and it is useless to try to change it; for example, Rachel Carson quotes a statement defining pigeons, starlings and English sparrows as "pest birds." The peregrine falcon, which kills other birds without bothering to eat them, is termed "noble". I shall stipulate, therefore, that public sentiment favors certain selected species of wildlife; it is objectionable to pick wildflowers, but praiseworthy to catch trout. Killing bald eagles in Alaska was encouraged by a 50 cent bounty, but I am glad to say that this has recently been stopped. Certain species, such as deer and waterfowl, are harvested by hunters, some of whom belong to the National Audubon Society. In general, the public opposes the extinction of any species, for even though evolution decrees that extinction of all species is unescapable, we rightly try to postpone it if the species is recognizable and conspicuous. I approve of this.

Dynamic changes in wildlife populations are in progress as a result of the human population explosion. Something is being omitted when DDT is a convenient scapegoat for the decline of certain species. Many species at the end of so-called food chains are also at the head of biological pyramids. The predators are examples of such species. A typical predator must have a habitat larger than that of his prey. Such large habitats tend to disappear as the human population increases is aggravated by hunters who like to kill predators and by farmers who shoot them as "varmints." A complete ecological picture is needed to assess declines in the population of predators.

There is no general tendency for wildlife in general to decrease despite the human population increase and the use of pesticides. Adaptation comes into play - adaptation to monoculture, suburbs and, in the case of jack rabbits, even to airports. Doubtless many wild species benefit from the use of DDT, because it kills the insects which transmit some major diseases of animals and birds. DDT also destroys ticks and lice.

Unquestionably, DDT has caused fish kills, but only a fraction of those caused by petroleum wastes, sewage, and industrial wastes. DDT and other insecticides as gypsy moth sprays have killed robins and other birds, but, as pointed out by Sir William Slater, many wild birds reproduce in much greater numbers than their habitats and food supply can accommodate.

An appraisal of the effect of pesticides on wildlife is highly complex because it is impossible to hold other factors constant. The major factor affecting wildlife is the increase in human population with all its consequences including spread of suburbs, industrial pollution, clearing and draining the land, building freeways. There is another problem; a psychological one: many (but not all) people professionally concerned with wildlife have taken an entrenched position against pesticides to such an extent that it is difficult for them to see any but harmful effects in the use of chemical pesticides. The peregrine falcon is said to be extinct in the Eastern U.S.A. although it was counted at Hawk Mountain in 1968 about 70% of its pre-World War II level. Decreases in wildlife are attributed to pesticide poisoning; increases to biological variation.

Critics of pesticides will even attribute increases of wild species to DDT if they decide that the species is undesirable, such as the spiny starfish in the coral reefs of the South Pacific. DDT is being blamed for this increase, because, it is stated, DDT may have killed off a natural enemy of the starfish. Why not, indeed? DDT is at fault, because like Mount Everest, "it was there." For the same type of reasoning, DDT and DDE are blamed for the breeding failure of brown pelicans in California. Why should the failure be so sudden? and why are the brown pelicans still thriving in Florida? The tissues of the pelicans have been reported to contain significant amounts of polychlorinated biphenyls, but DDE is blamed for the thin eggshells, apparently by an application of "McPherson's rule". According to Nature this states that: "when two men have been drinking, one of them a known drunkard, and the other man starts a fight, it is always the drunkard that gets the blame.". Using McPherson's rule, and without conducting controlled experiments, DDE has been blamed for the thin shells of eggs laid by pelicans on Anacapa Island.

The struggle of the peregrine falcon for its existence, against its personal antagonist - man - is described in a fascinating book, "Peregrine Falcon Populations", edited by Dr. Hickey.

Peregrines are relentlessly harassed and killed by pigeon fanciers, by ordinary hunters and even by park policemen. During World War II, the British Government systematically destroyed peregrine falcons because they killed carrier pigeons. Peregrine nests are robbed of their eggs by collectors, of their young by falconers, and the nests are destroyed by rock climbers. The habitat of the peregrine is being progressively invaded by human beings as a result of the human population explosion.

Non-pesticide reasons for the decline in peregrine falcons are stressed by many of the authors of this book, and I shall not list all of these scholarly and careful accounts, with their voluminous details. On page 220, Schroder, reporting from Germany, states:

> *"In his report (Chapter 17) on the cliff-nesting peregrines in the GDR Kleinstauber gave his opinion on causes for the decline based on decades of experience. Most of the suggested causes apply for the tree nesters as well: breaking up of broods by natural enemies; destruction by forestry activities and curious visitors; the increase in vacation traffic which is disturbing in general; destruction of preferred nest trees by storms; and in rare cases blundering of adult birds."*

Despite this mass of conflicting evidence, Hickey and Roelle have written the summing-up chapter of the book, "Conference, Summary and Conclusions", which rules out practically anything but chlorinated hydrocarbon insecticides as reasons for the decline of the peregrine falcon. The summary omits mention of the many other reasons for the decline of the peregrine falcon that are described in the book.

An article on DDT and five species of marine algae was published in Science by Wurster (Vol. 159, p. 1474, 1968). He added an alcohol solution of DDT to the culture medium of enriched sea-water. By this means, he introduced DDT into the cultures at levels up to 500 parts per billion (ppb) although solubility of DDT in water is only 1.2 ppb. He was thus exposing the algae to DDT in concentrations up to 400 times as great as would be encountered in an ocean saturated with DDT.

The algae in cultures containing 1 ppb of DDT carried out photosynthesis at the same rate as controls without DDT (one species), higher than controls (three species), and lower than controls (one species). The differences among controls are probably not significant, because at the next higher level of DDT (apparently 2 ppb from the graphs), photosynthesis was above that of the controls (three species) and below the controls (two species). At much higher levels of DDT, far above the solubility in water, photosynthesis was depressed - not surprisingly, because DDT is known to injure green crops when applied at levels higher than are necessary to kill insects. Salt injures plants, too, and salt is used as a weed killer.

Nevertheless, from these fragmentary results, obtained under laboratory conditions, various writers have not hesitated to tell the public that DDT will stop photosynthesis in the ocean; this despite the fact that Lake Erie is being overgrown by algae, and there are reports that the Great Lakes are contaminated with DDT in areas where there is a run-off from large cities. Indeed, Wurster pointed out yesterday that eutrophication is caused by over-fertilization from sewage, agricultural run-off and other artificial sources, and that algae blooms appear in closed bodies of water.

Wurster has listed four properties of DDT that are responsible for its behavior: - first, he says it is toxic to almost all animal life rather than simply the insect pest. This is an incomplete statement because it does not state the level; for example, insects are killed by levels of DDT that are not toxic to mammals. Actually Wurster points out in the current Reader's Digest that the lethal dose of DDT varies from species to species and that "It takes 50 ppm in the brain of a robin to kill the bird, but one-tenth of that amount will kill some fish; pheasants and herring gulls, on the other hand, can sometimes store thousands of ppm in their bodies without lethal effects." Second, he lists "persistence so that it lasts for a decade, and perhaps much longer." This is misleading, because under many conditions it is destroyed in much less time, depending on temperature, pH, sunlight, etc. Third, mobility, so that it is carried about the earth by water and air. This applies to all substances that are soluble and volatile. Fourth, solubility properties that cause it to be accumulated by living organisms. This property is probably necessary for a pesticide, and in any case is fairly common. The species properties listed by Wurster for DDT are therefore general properties of many substances.

The Clear Lake, California, incident is a favorite example used by the critics of DDT. The pesticide used in Clear Lake was DDD. DDD is less toxic than DDT to fish than DDT, but more toxic to birds. Breeding failure was described for the grebes, a diving bird that lives on Clear Lake. The last application of DDD was in 1957. In 1962, the grebes were starting to recover; in 1963, there was further increase in the number of grebes and in 1969, Dr. William Hazeltine, who is in charge of the project, reports that there are numerous young grebes on the lake.

Restoration of the bird life from the Clear Lake incident is seldom mentioned, but apparently it started within five years of cessation of spraying. It was recognized by the entomologists that DDD was the wrong choice, and methyl parathion is now used to control the Clear Lake gnat.

We heard yesterday some remarks which, in the words of the speaker, Professor Chant, were an attempt at rabble-rousing. He described the use of pressure methods to enforce the adoption of his opinions. This is the technique advocated, I believe, by Marcuse. There was applause from the audience, yesterday.

I warn all of you against this approach. Too many evils have resulted from it. In science, it resulted in Lysenkoism in Russia. This is graphically described in Lerner's book on Genetics, Evolution and Society, and first-hand in the book by Medvedev: The Rise and Fall of T. D. Lysenko.

The term "rabble" is one that I would not apply to this audience, to which I now address myself. I am a professor at Berkeley, and I always try to respond to requests by students for discussions of DDT. I am glad to see young people, students, in the audience. There is much to study on the subject of DDT. You need all this information, and more, for making the momentous decisions on the environment that confront you and there is a lot of it that has been withheld by EDF, which by its own admission takes a partisan rather than a judicial position.

It is easy to wave placards asking that DDT be banned. I wish you would wave placards asking that cigarette sales be banned. Have you asked yourself what a ban on DDT will do to millions of black people who can't read or write? How many references on the use of DDT in controlling tropical diseases have you read?

Perhaps human beings can understand the value of food only if they produce it by their own toil; fighting against drought, blight, and insects for the privilege of getting something to eat. Can we learn without repeating such bitter experiences?

The attack on DDT is part of a general attack on pesticides. America without pesticides would be a place where hunger and disease would dominate us. Among the diseases carried by flies and mosquitoes in the U.S.A. are diarrhea, dysentery, and encephalitis. These diseases, together with the swarms of insects that carry them, would surely come back. They would reduce the number of healthy people, and there would be far less food for everyone. To produce food, we would have to fight farm pests by primitive methods; burning cornstalks in the fall; picking worms and bugs off plants by hand; hoeing weeds. Far more farm labor would be needed. The food in grocery stores would contain insects and insect filth.

The food supply and health of the U.S.A., and the world, depend on the continued use of pesticides, including persistent pesticides. The chemical industry, the FDA, the USDA, and the National Research Council have all explained this. You, as voters, must make up your mind as to whether you prefer pesticides or pests.

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THE INFAMOUS RUCKELSHAUS DDT DECISION

The recent Ruckelshaus decision regarding DDT restrictions is an abject capitulation to professional environmental extremists and a tremendous defeat for science and mankind. Most concerned persons are mindful of the waste of holding seven months of federal "hearings" on DDT and then ignoring or rejecting all evidence which did not support the preconceived decision of this EPA Administrator. If Mr. Ruckelshaus was determined not to be influenced by any factual data, he should not have implemented such a costly, time-consuming legal charade! A major consequence of his ignoring the scientific record and rendering this fatuous decision on DDT will be the increased destruction of the environment which his Environmental Protection Agency (EPA) is supposed to defend! The "substitutes" recommended most highly by Mr. Ruckelshaus to replace DDT will needlessly destroy thousands of honeybee colonies and millions of birds and mammals.... which would NOT be injured by DDT applications. (Audubon Magazine reported more than 10,000 robins killed this spring by just one of those "substitutes" in one small area of Florida, and in one year California lost more than 83,000 colonies of honeybees to such "substitutes" which had been used on cotton after DDT was prohibited).

Another ill consequence of importance will be the certain death or injury which always follows the shift from harmless DDT to more toxic "substitutes", which Ruckelshaus has recommended. Hundreds of farm workers have already been killed and hundreds of thousands made ill by those chemicals, but the EPA and the EDF (Environmental Defense Fund) obviously do not object. Dr. Charles F. Wurster, Chairman of the Scientists Advisory Council of the EDF, reportedly stated in 1970 that "...the organo phosphate acts locally and only kill farm workers and most of them are Mexicans and Negroes" and that "People are the cause of all the

Defendant N.Y. Times Exhibit EE

problems. We have too many of them. We need to get rid of some of them and this is as good a way as any." (See the published record of Hearings before the Congressional Committee on Agriculture, Serial No. 92-A, 1971, pages 266-67.) It was Wurster's EDF with which Ruckelshaus sided so eagerly during the EPA hearings, in opposition to witnesses representing the U. S. Dept. of Agriculture, the U. S. Public Health Service, the World Health Organization, the United Nations Food and Agricultural Organization (FAO), and other concerned groups. The ultimate goals of the EDF have been explained as far back as 1969, in Bioscience 19: 809, by one of their leading spokesmen, as follows: "If the environmentalists win on DDT they will achieve, and probably retain in other environmental issues, a level of authority they have never had before. In a sense, then, much more is at stake than DDT." Perhaps that is an understandable goal for professional environmental fund-raising groups, but what justification can there be for the already-powerful Environmental Protection Agency to aid them so obsequiously?

For seven months the EPA hearings exposed the insincerity of anti-DDT cultists and the incredibility of their allegations. The hearings firmly established the facts that DDT: does not normally persist long in the environment; is not normally transported great distances from points of application; does not eradicate all beneficial insects; does not threaten birds, mammals, fish, or estuarine invertebrates; is not "magnified" to dangerous levels in food-chains; does not continue to persist or build up in living tissues; does not cause wild birds to form thin eggshells;and has not been shown to pose any health hazard to man or domestic animals.

For seven months, EPA/EDF witnesses who testified in the Washington hearings admitted to experimental bungling, ineptitude, shameless obfuscation, and the deliberate publication of errors and distortions in their "scientific" and pseudoscientific articles. The patient cross-examination of dozens of those "authorities" gradually revealed the enormity of the lucrative anti-DDT conspiracy. Under oath, there were a great many confessions of citing false information and deliberately omitting or altering significant data. The "authorities" repeatedly feigned ignorance of extremely significant details which are well-known to most scientists and students with a sincere interest in the DDT controversy. Some biologists employed in federal wildlife research on birds, for example, disclaimed knowledge of the results of annual Audubon Society bird counts, disclaimed knowledge of the results of the Hawk Mountain Sanctuary counts of migrating hawks, and disclaimed knowledge of details of articles which are the major source of DDT residue data in birds, water, soil, and other environmental components. These disclaimers were especially strong when the "unknown" knowledge was in strong disagreement with the "authorities". Dr. Philip Butler claimed ignorance of the research results of his own colleagues at Gulf Breeze, Florida (U. S. Dept. of Interior laboratory), who had found in 1969 that over 92% of all DDT, DDD, and DDE disappeared in 38 days from sea water. (Dr. Butler's 1971 National Academy of Sciences panel publicized the frightening propaganda that "As much as 25 percent of the DDT compounds produced to date may have been transferred to the sea." (page 1, in "Chlorinated Hydrocarbons in the Marine Environment").

It is obvious that Mr. Ruckelshaus did not attend the EPA hearings, and that he even failed to read the transcript of the testimony and cross-examination. His official "opinion" indicated no awareness of hundreds of very significant points that were clarified during those seven months of testimony or of the forced retractions of untruths by his EDF/EPA "experts". Also, he appeared unaware of the possible perjury in the testimony of some of his greatest "authorities"!

Hearing Examiner Edmund Sweeney, however, was present every day. He considered all of the testimony and evidence presented, was aware of the incriminating retractions brought about during cross-examination, and obviously studied the 9,300 pages of hearings transcript. His conclusion was that the benefits derived from DDT use far outweigh any hazards. "In my opinion, the evidence in this proceeding supports the conclusion that there is a present need for the essential uses of DDT...", stated the Examiner, and added: "DDT is not a carcinogenic hazard to man. DDT is not a mutagenic or teratogenic hazard to man. The usesof DDT under the registrations involved here do not have a deleterious effect on freshwater fish, estuarine organisms, wild wild birds or other wildlife" , and that "necessary replacements would in many cases have more deleterious effects than the harms allegedly caused by DDT". It seems remarkable that EPA Administrator Ruckelshaus, without attending the hearings and without reading the transcript, was able to decide that Mr. Sweeney (a federal examiner with 40 years of legal experience) was wrong in all of his major conclusions and probably erred in his handling of the case. Evidently Mr. Ruckelshaus in his wisdom did not need those seven months of testimony to aid him in divining a decision... in fact, it appears that EPA hearings are simply an expensive sham! If Ruckelshaus agrees with the decision he "approves" the results, but if he disagrees he ignores the evidence and issues his own ultimatum, regardless of the facts established during the hearings.

On 10 November 1971 Deputy General Counsel for the EPA, Mr. Alan Kirk, appeared at the hearings. He admitted (p 4583 of transcript) that he had not read the transcript of the previous day's proceedings (during which Mr. R. G. Heath contemptuously refused to answer a vital question and refused to provide data upon which he based his allegations), nevertheless Mr. Kirk had rushed over to criticise Mr. Sweeney's handling of the recalcitrant witness. While there, Mr. Kirk also stated (p. 4580) that the role of the EPA "is not that of an adversary, our role is as a representative of the 207 million American people..." It soon became evident that, on the contrary, the EPA was working in collusion with the EDF, and the Ruckelshaus "decision" on DDT frequently indicates the close association between EDF and EPA in this action, revealing the strong advocate position of the EPA. In the "Opinion of the Administrator" (page 4) it is stated: "The case for cancellation has been presented by counsel for the Pesticides Office of the Environmental Protection Agency and attorneys for the Environmental Defense Fund which is an intervenor." Later (page 8) Mr. Ruckelshaus writes that the EPA and EDF filed exceptions to the Examiner's report, challenging his findings of fact and his conclusions of law! That doesn't sound like the EPA maintained its non-advocate position very long!! It seems most unusual that this wealthy, tax-exempt anti-DDT lobby (the EDF), which legally forced the EPA to engage in a lengthy review procedure, ended up working hand-in-glove with the EPA in that action and even helped frame the EPA "decision" ruling that they (the EDF) were "right" about DDT (despite the evidence and facts to the contrary) and the Hearing Examiner was "wrong" about it!

Obviously, very few people will receive copies of the official "Opinion" by Mr. Ruckelshaus, therefore I shall discuss it very briefly here. The total document consists of a 40-page "Opinion", a 6-page outline of "Factual Findings", two paragraphs entitled "Conclusions of Law", and a 3-page "ORDER" which is based on "the foregoing opinion, findings, and conclusions of law". The ORDER is dated June 2, 1972, but was not released to most news media until June 14th. An appeal was filed just 30 seconds later in the 5th Circuit Court of Appeals, in New Orleans, so there will be several months in which scientists can point out the errors and dispute the conclusions in the Order, and the unbiased judges on that Court may be expected to reach the same sort of conclusion earlier held by Hearing Examiner Sweeney. The ORDER decrees that "Cancellation for uses of DDT by public health officials... and by USDA and the military... and use in prescription drugs is lifted." The ORDER also permits continued use of DDT for "control of weevils on stored sweet potatoes, green peppers in the Del Marva Peninsula (Delaware) and cutworms on onions..."

The Opinion is jammed with errors and misstatements, but I shall only include a small number of them here. Surely the others will also play an important role in the subsequent review of the decision by the Circuit Court judges.

1. What is DDT?

Ruckelshaus statement (page 1): "DDT is the familiar abbreviation for the chemical (1,1,1 - trichlorophenyl ethane), which was for many years..."

Corrections: DDT is not the chemical Mr. Ruckelshaus thinks it is, but is instead 1,1,1- trichloro - 2,2-bis (p-chlorophenyl) ethane. This error on the first page unfortunately is a harbinger of worse errors yet to come.

2. What does DDT break down into?

Ruckelshaus statement (page 4): "DDT has three major breakdown products, DDA, DDE, and DDD; separate registrations exist for TDE (DDE)."

Correction: TDE is the chemical that is also known as DDD, not DDE. These are entirely different compounds, and DDE is not even an insecticide! This fact is well known to most entomology students and to practically every grower and orchardist. Mr. Ruckelshaus must have been misadvised by some one who had heard about DDE because of allegations that it inhibits carbonic anhydrase, thus causing thin eggshells to form (an EDF theory which was refuted by at least five research teams last year). It might also be of interest to point out here that DDD does not even break down into DDE.

3. What substitutes will be used for DDT?

Ruckelshaus statement (page 37): "Such a program can also introduce farmers to the less acutely toxic organophosphates, like carbaryl, which may be satisfactory for many uses." (Emphasis added)

Correction: Carbaryl is a carbamate insecticide, not even remotely related to the organophosphates! This fact is well known to most entomology students and to practically every grower and orchardist.

4. What substitutes for DDT are recommended by the EPA Administrator?

Ruckelshaus statements: (page 36): "The record before me leaves no doubt that the chief substitute for most uses of DDT, methyl parathion, is a highly toxic chemical and, if misused, is dangerous to applicators."

(page 37): "Other testimony noted the increase in non-fatal accidents and attributed almost one-half reported pesticide poisonings to the organophosphate group."

(page 37): "I am accordingly making this order effective as of December 31, 1972, insofar as the cancellation of any particular use is predicated on the availability of methyl parathion as a substitute."

Comments: Why discard DDT as a "potential hazard", despite it's marvelous record of human safety and lack of environmental damage, and recommend a replacement which Ruckelshaus states is likely to cause so much poisoning?

5. Will substitutes cause environmental damage?

Ruckelshaus statements: (page 25): "Indeed, it may be that the same tendency of a chemical to persist or build up in the food chain is present but not known about substitute chemicals."

Comment: We know exactly what happens to DDT in the environment and in plants and animals. Why leap into the unknown unnecessarily and use great amounts of compounds about which he admits very little is known?

Ruckelshaus statements:(page 21): "While they are toxic to beneficial soil insects and non-target species, particularly birds alighting on treated fields, these organophosphates break down more readily than DDT."

Comments: Because they break down so readily, they must be applied much more often, also. When less toxic insecticides will control the pests, why outlaw them and use more toxic compounds?? Who will get the blame for killing the birds and beneficial insects? It SHOULD be Mr. Ruckelshaus!!

6. Did DDT kill off the fish and birds? (Is that why it is being phased out?)

Ruckelshaus statement: (page 16): "The Petitioner-registrants' assertion that there is no evidence of declining aquatic or avian populations, even if actually true, is an attempt at confession (sic!) and avoidance." (My emphasis added)

Comments: Ruckelshaus admits that even if there has been no decline, his mind is made up! What kind of justice is that?? Hundreds of pages of transcript prove that there was no decline which could be attributed to DDT use, and indeed that there have been practically no declines of birds or fish at all during the "DDT years". Such proof obviously has failed to impress Mr. Ruckelshaus even though he evidently believeditt.

7. Does DDT actually cause thin eggshells?

Ruckelshaus statement (page 18): "Viewing the evidence as a total picture, a preponderance supports the conclusion that DDE does cause eggshell thinning. Whether or not the laboratory data above would sustain this conclusion [it does not] is beside the point. For here is laboratory data and observational data, and in addition, a scientific hypothesis, which might explain the phenomenon." (My emphasis added.)

Comments: The laboratory data do not sustain the allegation. Why doesn't that fact deserve consideration by Mr. Ruckelshaus? The observational data do not sustain the allegation. Why doesn't that fact deserve consideration by Mr. Ruckelshaus? And of what value or significance is a "scientific hypothesis" that has already been proven wrong during seven months of EPA hearings and three years of scientific investigations by independent biologists whose salary is not linked to the anti-DDT hypothesis?

8. Is DDT mutagenic?

Ruckelshaus statement (page 13): "Mutagenic effects will be apparent only in future generations." (My emphasis added)

Comments: This is the old "for all we know" thesis. Obviously, after five or ten generations without any mutations, we will be told that "for all we know" mutations may be apparent only after another five or ten generations. The same scare tactics could be applied equally well to dangers from most modern medications, to vaccines, to drugs, to enriched vitamins, etc. It seems incredible that the Administrator of the Environmental Protection Agency would be this naive, for the substitutes he is recommending to replace DDT are just as open to the ridiculous charge as DDT, and they have not been tested nearly as long as DDT already has!

9. Is DDT carcinogenic?

Ruckelshaus statement: (page 29): "The possibility that DDT is a carcinogen is at present remote and unquantifiable;"

Comment: Despite this statement, Mr. Ruckelshaus was able to imply elsewhere that there IS no proof that at some future time any substance might not cause cancer. Thousands of mice and other experimental animals have already been exposed to incredibly great, long-sustained diets of DDT, but nobody with any expertise in cancer research will state definitely that DDT causes cancer. Unfortunately, some news media seemed to think this "decision" was based in part on the unknown future possibility that DDT might pose some hazard to man. Ironically, DDT is the only insecticide that has actually been ingested by man in massive daily doses for months or even years... with no ill effects whatever. No substitute will be able to make that record!

10. What is the function of the Hearing Examiner?

Ruckelshaus statement: (page 24): "Whatever extra weight, then, that might be due findings based expressly on a credibility judgement is not appropriate in the case before me."

Comments: Mr. Ruckelshaus evidently means that if the witnesses fail to tell the truth, and are proven to have perjured themselves, it will have NO

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effect on his decision against DDT. As a matter of fact, that is exactly what did happen during the hearings, and the Administrator seems to feel it necessary to explain why the lack of credibility of his witnesses has not affected his decision.

Ruckelshaus statement: (page 24): "The precedents, moreover, make clear that the Agency (EPA) is free to make its own findings and that the Examiner's findings and report only comprise part of the record which a court will then evaluate." (My emphasis added.)

Comment: If the Examiner's findings and report were supposed to be evaluated by a court, why did Mr. Ruckelshaus do it? If Mr. Ruckelshaus was supposed to evaluate the Examiner's findings and report, why does he then state here that "a court will then evaluate" them? Certainly if a court evaluated the report by Mr. Sweeney, (the Hearing Examiner), they would not arrive at a decision that was in direct opposition to his on every point, as was done by Mr. Ruckelshaus! Perhaps that is the only way to obtain justice from EPA?

This capricious act by the Environmental Protection Agency administrator is a matter of great importance to the average American.... it will directly affect his environment, his food supply, his personal health and safety, and his cost of living. He has long been upset by extremists in the environmental movement and by unreachable beaurocrats, but he seldom knows what to do about it. THIS time there IS something he can do. He can send letters and telegrams to the Environmental Protection Agency, with copies of all letters also sent to the U. S. Department of Agriculture, in Washington D. C., and copies to his federal legislators. If public concern matches that of the agriculture officials, the public health service, the world health authorities, and the legislators, constructive action certainly will be taken to correct this latest injustice!

J. Gordon Edwards

J. Gordon Edwards

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To present in
23 Feb 1972
At 71st National Meeting
of American Institute of
Chemical Engineers

ENVIRONMENTAL KANGAROO COURT

Concerning
Dichloro Diphenyl Trichloroethane
(D D T)

Dr. J. Gordon Edwards
Professor of Entomology
San Jose State College

I oppose the campaign to outlaw DDT in the United States because: 1.) Such actions are unnecessary; 2.) A ban on DDT use would be genocidal; 3.) It is irresponsible to ban DDT in defiance of the testimony of most medical, agricultural, entomological, and public health experts; and 4.) The propaganda directed against DDT is lacking in objectivity, credibility, and scientific ethics and truthfulness. I shall discuss these points in detail.

1. A ban on the use of DDT is unnecessary.

Regulations already exist, both on the local and the federal level, which are strict enough to protect the public from pesticides, including DDT. If those regulations are complied with the public will have no need to be concerned about the use of any insecticides. DDT does break down under environmental conditions in a matter of weeks or months, ~~under field conditions,~~ rather than persisting for decades as anti-DDT propagandists have alleged. I have compiled a list of nearly 150 references documenting the breakdown of DDT and its metabolites, which is available to interested persons (an annotated copy is attached). DDT, it is obvious, is degraded by chemical, thermal, and biological factors in the environment. Its lack of extreme persistence is documented by hundreds of tests on soil, water, air, and tissues of live and dead plants and animals. Since 1960 the levels in environmental sites have steadily declined, and the amount in human fat tissues has fallen from about 12 parts per million (p.p.m.) to an average of only 4 or 5 p.p.m. (this includes the metabolites or residues, as well as the actual DDT). Heavily exposed industrial workers bearing several hundred parts per million of DDT have not suffered any adverse effects, but on the contrary have apparently gained protection from cancer and tumors during the past 22 years of heavy DDT exposure. U. S. Public Health Service publications and investigations bear out that contention. Most other vertebrate animals are similarly unharmed by DDT and residues in the environment, and there are numerous indications that they are actually benefitted by the presence of moderate amounts of the chemical in their environment and in their body tissues.

The environmental effects of DDT are minor, despite the spectacular charges directed against this chemical by environmentalists and their organizations (Environmental Defense Fund, Sierra Club, Audubon Society, etc.). The allegations usually emphasize hazards to fish, birds, and "beneficial invertebrates", but they are based primarily on simple correlations between the presence of DDT (or residues) and the occurrence of ill health, reproductive difficulties, or death. They fail to prove the allegations because they ignore dozens of other environmental components which are at least as likely to cause the ill effects, and because they omit explanations of healthy animals that contain much higher residues than do the unhealthy ones.

Defendant N.Y. Times Exhibit FF

Efforts to "prove" correlations by means of laboratory "experiments" have been repeatedly analyzed and most have been found to be tendentious, to involve multiple variables, to contain incredible errors, or to be lacking in essential background data. They tend to quote other authors and cite other articles as being confirmatory even when they are not, to rely on unpublished beliefs obtained from other anti-DDT activists, to omit all data that fail to conform with their own hypotheses, and to report "conclusions" which are unsupported by the data available. The reader's alarm is heightened because he is usually not told how astronomical the dosages are (customarily many thousands of times the amount in human diets) or how much smaller are the amounts likely to be encountered under environmental conditions by birds, mammals, fish, or other forms of life. Frequently the doses are administered by unnatural means, also, including direct injections into the body cavity, into the uterus, or under the skin. Weanling mice at the Bionetics Laboratory were fed huge doses for three weeks via stomach tubes (200,000 times the mg/kg intake of DDT by humans) but still survived. Equally high doses were injected directly into the uterus of baby mice on their 2nd, 3rd, and 4th days of life, by Heinrichs, in a vain attempt to show adverse reproductive effects might be caused by DDT. Customarily the reports released to the press simply state that the mice "were given DDT", and public then assumes that "if it happens to a mouse it might happen to US".. ..which of course was exactly the intent of the "experimenter", all the time!

DDT has been blamed for causing massive fish kills. Interested persons should ask the U. S. Government agencies for charts and graphs documenting the actual causes of fish kills in the United States. They will then learn that ALL pesticides combined have been killing less than 3% of the fish killed in the United States (and DDT killed only a small fraction of that percentage). The major killers of fish are industrial wastes and human sewage.

DDT has also been blamed for killing off big game, or for diminishing numbers of other wildlife. To the contrary, the Annual Big Game Census compiled by the U. S. Department of Interior shows a phenominal increase in big game harvested annually since the use of DDT began (that harvest almost doubled, between 1948 and 1967).

The success of most bird species during the DDT years is evident to everyone who spends much time outdoors. Judging from the widespread increase in abundance of the birds that live in rather close proximity to man, our modern pesticides have actually helped the birds, rather than harming them. The figures from Audubon Christmas Bird Census records are very interesting, for they definitely indicate a trend upward in most kinds of birds between 1941 and 1960 (our use of DDT declined abruptly beginning in 1960). Those census reports showed an increase of 12 times more robins, 21 times more cowbirds, 38 times more blackbirds, 131 times more grackles, and so forth. More recently, news accounts documented great swarms of blackbirds, red-winged blackbirds, grackles, and robins in many parts of the country. In the summer of 1971 the National Audubon Society sought and received permission to poison 30,000 gulls on one island off the Massachusetts coast, even though gulls are "protected" birds in that state. (That same organization has frequently pointed with alarm at "cracked eggshells" and "high DDT levels" in gulls, but we now see that their numbers have certainly not been declining!) We should also notice that during the DDT years wild turkeys increased from their extremely rare status to such numbers that hunters can now harvest more than 130,000 of them yearly,

BEST COPY AVAILABLE

and mourning doves became so abundant that hunters harvested more than 41,000,000 of them in 1965. Raptorial birds have also increased, despite the propaganda efforts to convince us that they were threatened with extinction by DDT and the allegedly-resultant thin eggshells (a shameless untruth). The records of the Hawk Mountain Sanctuary in Pennsylvania have revealed a steady increase in migrating hawks of most kinds, culminating in the sighting of more than 29,000 there in 1968. Numbers of ospreys climbed even higher in 1969 and 1970 (they increased from less than 200 in 1945 to more than 600 in 1970, showing a gradual annual increase during that period of time). This increase occurred even while the anti-DDT groups were shouting that ospreys were "headed for extinction"! Bald eagles continued to increase in rural areas, and the Audubon Society in 1970 belatedly increased their official estimate of the number of bald eagles in Montana from 130 up to 208, after rangers in Glacier National Park had counted 373 of the great birds in half a day along half a mile of McDonald Creek there in 1969. The White-tailed Kite, a predator that was formerly very rare and local, has greatly extended its range and has experienced a tremendous population explosion in California.... all during the very heaviest years of DDT usage there! The anti-DDT team continues to express great concern, even while flocks of birds darken the skies and hunters experience longer hunting seasons and larger bags every year. Incredibly, much of the public has been convinced that there really is a decrease in numbers of birds, AND that the decrease resulted from DDT and the thin eggshells it caused.

2. A ban on DDT would be deliberately genocidal.

The campaign to ban DDT in United States doesn't bother me personally nearly as much as the further exhortation to ban exports of DDT. Such a move would result in at least five million human deaths annually and perhaps close to 50,000,000 deaths if we also include those who starve as a result of being deprived of DDT to protect their crops. The Audubon Society has distributed hundreds of thousands of leaflets to students and teachers, and those leaflets bear the dictum: "DDT should banned throughout the land, and banned from export". That leaves little doubt as to the stand of the Society concerning those suffering millions of non-white humans in the tropics who will die without insecticidal protection from vectors of disease. A UPI news release from San Francisco (25 February 1971) quotes the Executive Director of the Sierra Club as follows: "The Sierra Club wants a ban, not a curb on persistent pesticides, even in the tropical countries where DDT has kept malaria under control". What interpretation other than genocide can one place on that remark, by the medical doctor who stated it? (I really don't believe many of the Club's members would agree with the statement, IF we were informed about it in the Club Bulletins... but we were not.) As a member of the Sierra Club I have vigorously protested such actions in letters to the members of the governing board, but have not even received answers to my letters.

Most nations in the world today are dependent on DDT for control of the greatest killers of mankind.....malaria, yellow fever, typhus, plague, sleeping sickness, encephalitis, Chagas' disease, Oroya fever, and kala azar, and for control of disabling diseases such as river blindness, elephantiasis, and leishmaniasis. There can be no moral or ethical grounds for deliberately withholding medication from those people OR for depriving them of DDT. Such action goes far beyond the senseless penalizing of our own citizens by banning DDT for agricultural or public health purposes. In United States we can often kill the vectors of insect-borne diseases by utilizing substitutes for DDT. Unfortunately, those are 3 to 25 times as expensive as DDT and have undesirable side effects. The poor inhabitants of many tropical countries cannot possibly afford such substitutes, and neither can their governments or the international humanitarian organizations such as the World Health Organization or the Agency for International Development. (Even though they could get DDT for less than 20 cents a pound and successfully control malaria with it, many countries still have not been able to afford a malaria eradication campaign!)

3. Banning DDT in the United States would be an extremely irresponsible action.

The following points indicate a few of the difficulties that will result from a ban on the use of DDT in this country. The list could obviously be expanded upon almost indefinitely.

(1) A ban here would frighten or alarm underdeveloped countries so much that they might terminate their public health uses of DDT, allow crops to be ruined by insects, and live with abundant human parasites, rather than risk being "poisoned" by DDT (for they could not be fully aware of the true nature of the propaganda involved in the "ban DDT" movement in the United States).

(2) We may yet be invaded by insect-borne diseases, as more foreign travel occurs and more pathogens are imported by returning travellers.

(3) More diseases of wild birds will occur, because the substitutes cannot adequately control insect vectors in the natural habitat as DDT did. Such diseases include avian malaria, bronchitis, fowl-pox, and many others.

(4) Aflatoxins in the food are known to be detoxified by the enzymes that DDT causes the liver to produce. Without that detoxification, birds and mammals will continue to die of cancer, because aflatoxins are among the most potent carcinogens known to science and are commonly produced by molds that occur in natural food sources.

(5) U. S. Public Health Service scientists who have studied the effects of DDT and its analogs on tumors and cancer say that it may inhibit cancer formation and prevent tumor production or development.

(6) A ban on DDT would contribute to a decrease in production of food and fibre in the United States and would increase the cost of production.

(7) American cotton growers, truck crop farmers and orchardists really need DDT for many specific insect control programs. Banning it would limit their productivity and may cause severe losses to many of them. It may force large numbers of agriculturalists out of business and discourage others from entering agriculture because they fear a future trend in banning farm chemical

(8) The "substitutes" for DDT are believed to kill more than 200 people annually, even though DDT and its residues have never killed anyone. The long-term effects of those substitutes are largely unknown.

(9) Banning DDT would result in the destruction of thousands of honeybee colonies, because the "substitutes" are generally much more toxic to bees than DDT. Without bees to pollenate the crops, much poorer yields result.

(10) Forests will suffer more in the absence of DDT, because "substitutes are more likely to destroy parasites and predators of pests than does DDT. Gypsy Moths will continue to devastate the eastern hardwood forest, unchecked.

(11) Native shrubs and other ground cover will be damaged or destroyed by natural enemies, and that in turn will result in more erosion and in downstream flooding during rainy seasons. (Because of fewer roots to hold the water.)

(12) Fewer protective areas of cover and concealment and fewer good nesting places will be available after DDT is banned, because more land must be placed under cultivation to compensate for the loss of productivity of existing agricultural land.

(13) With fewer trees and other vegetation, substantial reductions in humidity and elevation of temperature occur, and those changes will cause decimation of birds, mammals, and herptiles, as well as native insects.

(14) Adverse effects on U. S. economy will result from a ban on DDT. Losses of crops, lowered yield, food shortage, higher prices for food and supplies, increased malnutrition, curtailment of farm income, loss of employment, declines in local bird populations, decimation of forests and ornamental trees, and so forth will all threaten as a result of the ban on DDT (and subsequent bans on other insecticides would further aggrevate the situation).

(15) If DDT is banned, despite its high degree of safety to man and the environment, legislatures throughout the nation will quickly be questioned: "If DDT was too destructive to use, and was banned because of that fact, ~~so~~ HOW can we still permit the use of dieldrin, aldrin, chlordane, heptachlor, and all the other insecticides that are many times greater in toxicity than DDT and are in many cases much more persistent than DDT, AND are known to be more destructive to birds and other forms of wildlife than DDT." We have already been told by spokesmen for the opposition that such is their ultimate goal...to ban or strictly limit the use of all farm chemicals. DDT is just the start!

4. The campaign against DDT lacks objectivity, credibility, and truthfulness.

"Most scientists grew up, as I did, with truthful, trustworthy friends and colleagues. It is quite a shock, therefore, to discover that some of our modern scientists have deliberately obscured facts, distorted and misstated data, misquoted sources, padded references with statements only by co-conspirator and entitled their articles in such a way as to conceal the actual significance of their observations. I am sure that most of us are now aware of the demise of objectivity, of careful analysis, of data verification, and of critical scientific review prior to publication.... the old days of scientific ethics and morality seem remote. We can cite dozens of examples of flagrant perfidy in articles which are being utilized in the attempt to eliminate DDT and other chemicals." If time permits I shall discuss several of the myths that have characterized the anti-DDT campaign during the past three years. The topics that are in greatest need of discussion and clarification include: (1) the alleged "bird declines due to DDT" (eagles, robins, osprey, peregrines, gulls and pelicans); (2) the "thin eggshell" hoax; (3) the "inhibited photosynthesis" fantasy; (4) the myth of "biological magnification up the food chain"; and (5) the unsupported allegations that DDT causes ill health in the form of hepatitis, poliomyelitis, tumors, cancers, sterility, softening of the brain, et Scientists are in a good position to determine the validity of these allegations but laymen, elementary and secondary school teachers, bird-watchers, Sierra Club members, Audubon Society members, and other "environmentalists" lack the technical background needed for legitimate evaluation of the allegations. This has been the strongest weapon of the Environmental Defense Fund!

I hope that a great many truly-qualified scientists will take the time to carefully read and evaluate the anti-DDT articles and speeches, and will then transmit their evaluations to their own colleagues and to all non-scientists who are concerned about the controversy. I feel that scientists MUST take that action, regardless of the outcome of the DDT persecution in the courts. Even more important than the issues of genocide, financial disaster, and environmental destruction is the principle of scientific truthfulness and credibility. If the public loses confidence in science and in scientists, as a result of the tactics used by some scientists to untruthfully incriminate DDT, 2,4,5-T, saccharin, cyclamates, monosodium glutamate, food coloring, phosphates, yogurt, drinking water, fish, farmers, industrialists, and birth control pills, then we will have lost not only the battles but also the war! We must not allow that to happen to science in America!!

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THE ROLE OF AGRICULTURAL CHEMICALS IN FEEDING AN EXPLODING POPULATION*

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The Reverend Thomas R. Malthus in his brilliant Encyclopedia Britannica article "A Summary View of the Principle of Population" stated in 1824:

"... that population, when unchecked, increases in a geometrical progression of such a nature as to double itself every twenty-five years" ... "But by the laws of nature ... the food which it produces ... must increase the means of subsistence only in an arithmetical progression."

In spite of the derision and disrepute into which the Malthusian Theory has fallen over the intervening years, Malthus was absolutely correct. The population of the world has increased geometrically, and in spite of wars, famine and disease has done so with surprisingly little deviation for about the last 7000 years.

"DOOMSDAY" PREDICTED

Recently Foerster, Mora and Amiot writing in *Science* (Vol. 132 No. 3436: 1291: 11.4.60) computed the course of world population from 5000 BC till today and calculated "doomsday" as 13 November AD 2026. "Doomsday" is defined as the day when the population of the world arrives at 50 billion, or at 10,000 people per square mile of land surface. The present population of Japan (and the State of New Jersey) approximates 800 people per square mile.

Obviously any conceivable expansion of our food production will not be able to meet the minimal nutritional needs of a population approaching even 25 billion.

For today, with a world population approaching three billion, approximately four out of every five people die directly or indirectly from the effects of starvation. Between three- and four-fifths of the people now have an average daily gross intake of not more than 1800 calories per day, which is excessively aggravated by serious nutritional imbalances of both protein and vitamins. The World Health Organization of the United Nations reports that upwards of 50 per cent of the world's people ingest less than 1500 calories a day—a status of direct starvation.

The minimal arable acreage requirement to sustain one human in food (2200 calories/diem) and fiber was established in 1945 as 2.5 acres. In

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* Presented at the 66th Annual Conference of the Association of Food & Drug Officials of the United States, Hollywood-by-the-Sea, Florida, June 17-22, 1962.

DEFENDANT'S
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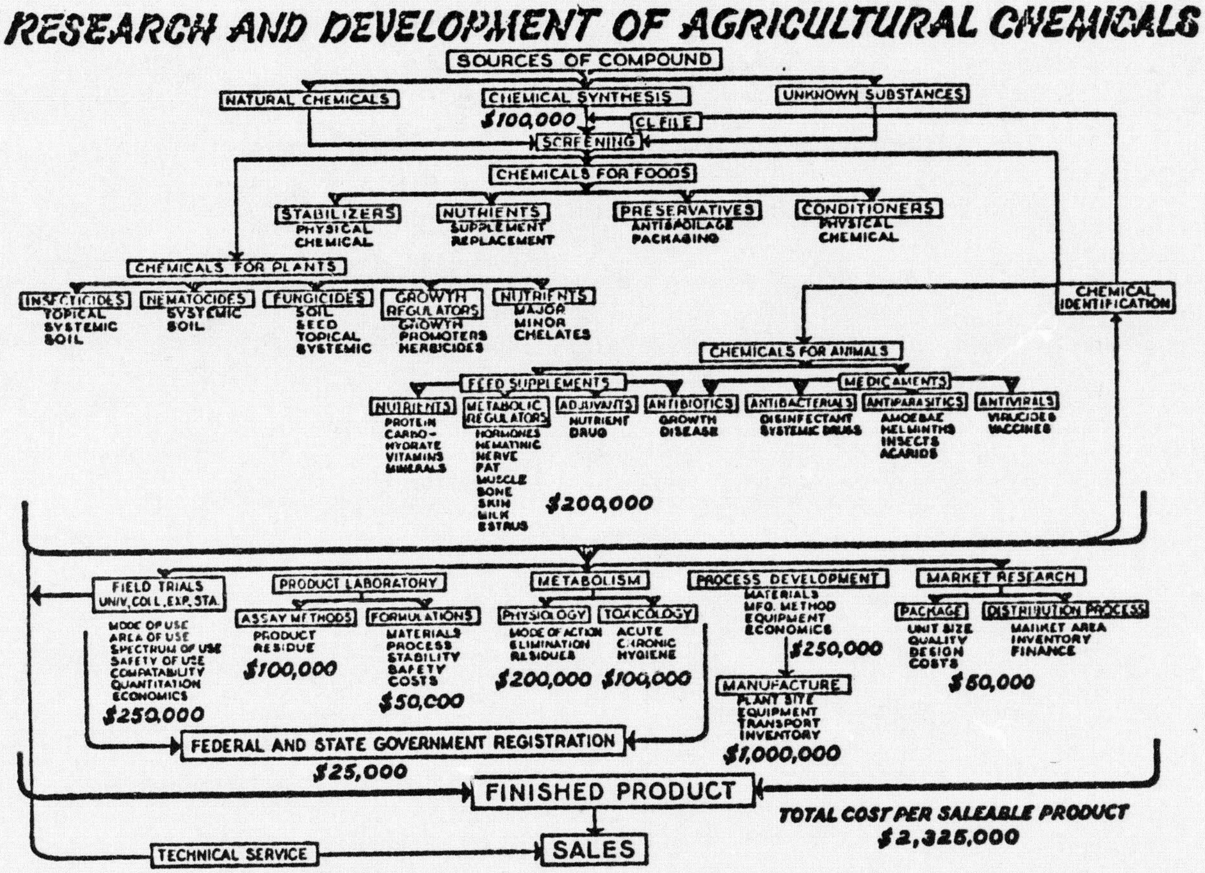
RESEARCH AND DEVELOPMENT OF AGRICULTURAL CHEMICALS
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DRUG
ANTIBIOTICS
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DISEASE
ANTIBACTERIALS
DISINFECTANT
SYSTEMIC DRUGS
ANTIPARASITICS
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HELMINTHS
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ACARIDS
ANTIVIRALS
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VACCINES
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FIELD TRIALS
UNIV, COLL, EXP. STA.
MODE OF USE
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SAFETY OF USE
COMPATABILITY
QUANTITATION
ECONOMICS
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PRODUCT LABORATORY
ASSAY METHODS
PRODUCT
RESIDUE
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FORMULATIONS
MATERIALS
PROCESS
STABILITY
SAFETY
COSTS
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METABOLISM
PHYSIOLOGY
MODE OF ACTION
ELIMINATION
RESIDUES
$200,000
TOXICOLOGY
ACUTE
CHRONIC
HYGIENE
$100,000
PROCESS DEVELOPMENT
MATERIALS
MFG. METHOD
EQUIPMENT
ECONOMICS
$250,000
MANUFACTURE
PLANT SITE
EQUIPMENT
TRANSPORT
INVENTORY
$1,000,000
MARKET RESEARCH
PACKAGE
UNIT SIZE
QUALITY
DESIGN
COSTS
DISTRIBUTION PROCESS
MARKET AREA
INVENTORY
FINANCE
$50,000
FEDERAL AND STATE GOVERNMENT REGISTRATION
$25,000
FINISHED PRODUCT
TOTAL COST PER SALEABLE PRODUCT
$2,325,000
TECHNICAL SERVICE
SALES

FIG. 1

the United States in 1955 there were 2.80 acres of arable land per person (population 164 million); in the world as a whole there were 1.25 acres per person, with considerably less in the populous countries of Asia. This allowed surplus food production in the United States, where indeed overeating became a problem, but in the rest of the world great areas have been at or near starvation.

By the year 2000 the population of the U.S. will approach 400 millions and the arable land, including anticipated reclaimed lands, will be 1.16 acres per person; in the world as a whole, however, there will be less than half an acre of tillable land per person.

"AN EMPTY BELLY . . ."

It is obvious that this presages catastrophe for our type of civilization, unless food and fiber production can advance at a greatly accelerated rate. The political-economic impact of this struggle for the bare necessaries of life has been gaining increasing momentum over the past half-century, and the international unrest and tensions of the present are a reflection of the strain between availability and need for food. The tension will inexorably increase, for when men approach hunger they have nothing to lose, and gain can be the only reward of survival. A Russian proverb says, "An empty belly knows no law."

M. C. Chagla, Indian Ambassador to the U. S., stated:

"I want you Americans in your land of plenty to imagine what it means for tens of millions of children to be born who will suffer from malnutrition, who will have no homes to live in, who will have no employment when they grow up, if they grow up, and who will spend their entire lives as disgruntled, envious and embittered human beings—a ready prey to any idea, no matter how monstrous, which might promise them surcease from their squalor and escape from misery, a hope for better prospects and a life more tolerable to live."

WHERE COMMUNISM GERMINATES

Mr. Chagla has described the fertile ground in which the seeds of communism and anarchy can germinate and flourish and has remarked the basic cause of political unrest among the seething masses of southern Asia. Similar conditions are developing rapidly all over the world, and touching our own continent in Central and South America today.

Even in America our population is increasing at a rate calculated to remove our politically embarrassing food surpluses in but a relatively few years. To feed this population in the United States we shall require by the year 2000 an additional 400 million acres of arable land, assuming we can maintain our present yields and productive efficiency. As we do not have

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such arable acreage available, we must turn elsewhere to meet this inevitable demand. Alternatives include extending our hegemony over foreign and probably already overcrowded lands, a course repulsive to our very national ethics, or embarking on an intensive population control plan, a matter of great political and spiritual controversey (but none the less inevitable), or we can turn to science and research and expand our food and fiber production far beyond the furthest reaches of our present horizons. We are, in fact, doing this now, for our food production is increasing as rapidly as our population, at least for the present.

In this land of apparently interminable surpluses, we have become not only physically surfeited but complacently apathetic about our food supply. The relatively small cost of our surplus is today a major political issue, yet it is really a minor expense for the insurance it bestows upon the income of the farmer and the cost of food to the consumer. A five per cent food surplus costs the nation only a fraction of what a similar deficit would cost the housewife in increased food prices.

The biblical Joseph stored a surplus of grain in ancient Egypt for the seven lean years, and has been accorded the wisdom of the ages for so doing. Today our surplus would hardly carry us for seven lean months, and if used to feed the hungry peoples around the world, it would be exhausted in less than two months. Thus even with our proficient agriculture and our surplus abundance we are, in fact, not more than a year or two away, at the very most, from starvation right here in America. This, then, is the frame of reference within which any major factor affecting agriculture must be viewed.

"FOOD EXPLOSION" NEEDED

So apart from a general world population control—a "peoplo-stat"—the only factor which can possibly relieve the increasing international stress is a "food production explosion" to match that of the world population. Although it is obvious that some form of population control is inevitable, a world "food production explosion" is now quite feasible.

Indeed, such has already taken place in the United States during the past 50 years and it can continue with accelerated tempo. If political, social and particularly religious mores can be swiftly swept aside, an equally effective "food explosion" can be accomplished around the world within the next half-century, to the immense relief of most of the international tensions which disturb mankind today.

The Foreign Research Service of the U.S.D.A. has recently computed that the total deficiency of food in the world today aggregates 46 million metric tons of protein-calorie equivalent, which represents 35 per cent of current U. S. milk production plus 45 per cent of bean and pea production

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and plus 120 per cent of U. S. wheat production per annum. Vast as this deficiency is, it is within reach of increased production in North America alone, and could easily be attained in the world as a whole.

"KNOW-HOW" AVAILABLE

There is now on hand the requisite technology, know-how, equipment, supplies, facilities and capital to increase the world production of grains, pulse, meats, vegetables, fruits, dairy products and fish by a factor of ten within the next decade. It has taken the United States and the other Western nations 150 years to resolve the myriad natural problems which had held farming in chains for five millenia; but now these difficulties have yielded to the advance of science and the fantastic productivity of the American farm is the proof of our success. For we have truly made four blades of grass, four ears of corn, four hogs and four fruits to grow where (as one frustrated Congressman on the Agricultural Committee said), "Damn it! only one ought to grow." We have done this and we could, with effort, make it eight or even sixteen.

This has come about through research and the rapid and assiduous application of its findings literally to the grass roots out on the farm. Our land grant college system, now celebrating its centennial, has taught our rural peoples how to farm scientifically and has, more importantly, inculcated a thirsty curiosity among them to learn and to put into practice every original idea, new piece of equipment, improved strain of animal or plant, useful chemical, redesigned soil management program and fresh approach to the market which their research has produced in a continuous flow over the past century.

We have drawn upon the basic researches of many fundamental and pragmatic sciences in the solution of problems in the production of our food and fiber. The hundreds of thousands of published and recorded journal papers, station bulletins, reviews and texts stand witness to the stupendous intellectual and physical effort which has been devoted to increasing the productivity of American agriculture.

ASTOUNDING BREAKTHROUGHS

We have done this because we have used the scientific method under freedom of thought and enterprise. We have made astounding breakthroughs in plant and animal breeding, in soil management, in forest engineering, in pest control, in agricultural machinery, in animal nutrition and disease control, in food processing and distribution. Each factor has been linked into a continuous chain extending from scientific imagination to the farmer tilling the soil. The research scientist, the technical agriculturist, the industrial chemist, the biologist, the college professor, the county agent and the farmer have, hand in hand, advanced relentlessly over the past century and subdued, one by one, the most baffling problems and scourges that have beset and plagued mankind since the dawn of history. It has been the work of many people and each has been as important and significant as the other. Great names in agricultural science have come and gone and are revered among us, but no one can assume credit for more than a minute fraction of this great achievement. It has been perhaps the most resounding victory democracy has won.

This is a victory we cannot and must not allow to slip away. It is our margin of security in the modern world. Yet this is precisely what can happen if certain forces currently abroad are allowed to range unchecked and unchallenged. I refer to recent developments in the pesticide and Food Additive Laws, to the administrative interpretation of these laws, and particularly to the wild and fearful publicity which has been made of these laws and their relationship to the use of agricultural chemicals and feed additives on the farm and to the health of our people.

THE "DELANEY CLAUSE"

No one questions the validity and necessity of Federal and State laws designed and administered to protect the health of the consumer of farm products; and every responsible worker in agricultural research, extension and industry recognizes the necessity to establish the safety, as well as the efficacy, of every new chemical to be used in or on edible crops and foodstuffs, *before* such a compound is released for general use. The recent amendment which centered the responsibility for such prior proof of safety upon the manufacturer is just and certainly acceptable to industry. However, attached to the amendment at the last moment was a clause, known as the "Delaney Clause," which, in a few words, if administered literally would reduce the whole agricultural chemical industry and, more important, its function on the farm to a veritable shambles. This circumstance can stop the rapid advances of agricultural science completely, for it will discourage the chemical industry from searching further for new compounds with which to combat the unresolved scourges of the farmer, and it will inevitably leave the grower at the mercy of a thousand pests which will boil back with both relish and alacrity once the pressure of control is removed. The impact of this will be, of course, not only a rapid decline in the volume and variety of the bright array of foodstuffs to which we have so happily become accustomed, but more significantly it will result in a sharp rise in its price—by perhaps a factor of as much as tenfold.

LACK OF DEFINITION

The Delaney Clause states that no residue tolerance is allowable on any chemical used in or on a food or feed product if it is "found to induce cancer when ingested by man or animal." On the face of it this sounds reasonable enough, and certainly no responsible scientist, industrialist, food processor or farmer advocates the increase in cancer under any circumstances. The problem arises from the blanket coverage and lack of definition in the Delaney Clause. No indication is given as to how a compound is to be identified as a carcinogen—or cancer inducer—and this is a very debatable point even among cancer specialists. No indication is made as to what dosage level can be allowed or how the resulting residue tolerance can be determined, and as a zero residue is obviously an impossible value to measure, a suspect compound cannot legally be used at all, even under a zero residue registration. For, as analytical procedures are refined, what is a zero residue today may be a detectable or even appreciable level tomorrow. Finally the Delaney Clause implies the compound must be proven to be noncancer inducing in humans as well as in animals. This is a manifest impossibility to achieve even if such experimentation was feasible, for one may be able to prove a compound *is* a carcinogen, but one cannot prove it is not, anymore than one can prove one is not married. By strict interpretation then, the Delaney Clause virtually precludes all new compounds from the agricultural and food market.

SUPERSTITION GAINS ASCENDENCY

As with all such matters of general concern and vast complexity, ample opportunity is provided for misunderstanding, illogical conclusion and unfounded fear to arise. In such an atmosphere, decisions of policy affecting the welfare and livelihood of millions of people may be based not on knowledge but on a lack of it, and prejudice and superstition gain ascendency over scientific truth. In recent months, while hesitancy reigned in administrative quarters, a noisome and prevaricative publicity has been made of these new laws, of their relationship to the use of agricultural chemicals in the production, processing and distribution of our foodstuffs and of the alleged hazards these substances may have upon the health of the people. A wave of fear and alarm has been deliberately fomented among the consumers of our country, a wave calculated to sweep away the trust, assurance and honest thinking in the business of agriculture and food production that it has taken our agricultural colleges, experiment stations and industry nearly one hundred years, and uncounted effort, to establish.

This critism, essentially destructive in tenor and intent, is based on half truths, scraps of irrelevant and unrelated evidence, much of it taken out of context and out of time, and largely founded upon superstition and outright falsehood. Books have been published under sensational and misleading titles by authors with neither training nor experience in the fields they purport to discuss; articles have appeared in obscure journals whose goal has been circulation rather than veracity; and the net effect has been

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to incite fear and consternation among the consumers of America out of all proportion to any possible or real danger involved.

A.M.A. POSITION

The Council on Foods and Nutrition of the American Medical Association has recently (*J.A.M.A.* Vol. 178 No. 7: 11.18.61) published the following official statement:

"The Council on Foods and Nutrition recognizes the contributions that chemical substances in food production, processing, and preservation have made to the quality and quantity of the American food supply. While many chemical additives are essential to efficient agricultural production, others are vital to the manufacture of food products. There is no reason to believe that the present use of chemicals in foods is endangering the health of people. Responsible manufacturers have made careful safety tests before the introduction of new chemicals, and the Food and Drug Administration is diligently and effectively protecting consumers from presence of hazardous chemicals under existing federal laws.

"It is the considered opinion of members of the Council on Foods and Nutrition that the Delaney Clause . . . and the similar clause . . . in the Color Additive Amendments . . . prohibiting the setting of tolerances for the use of carcinogens in foods should be either repealed or revised. Technically, this special provision contributes nothing to the safe use of food additives since any hazardous use of an additive is already prohibited in the general provisions of the food additive amendment. It is probable that the clause could prohibit the addition of certain essential nutrients to foods if a substance was shown to be carcinogenic in any amount. A literal and overly broad interpretation of the Delaney Clause would not make a demonstrable contribution to public safety."

Many statements have appeared recently in the popular press which are deliberately calculated to generate electoral support for those who propose legislation that only hampers the progress of our agriculture and with it the highest standards of living, health and happiness that man has ever known. The only alternative offered for our present process of agriculture by these critics is to return to the jungle and employ the so-called natural or "organic" way of life. It never occurs to them, apparently, that this is precisely the way some three-quarters of the people of this earth do live now—if it can be called living. There are hundreds of millions of wretched, crawling human beings desperately clawing their way from one scrap of food to the next, with neither thought nor desire for the science of farming to improve their lot. This is to what the natural, "organic" way of life has chained them. It could very readily also reduce us to the same bondage if we should abandon the scientific process in our agriculture. One point is clearly certain: nature would quickly re-establish her balance, and the first factor to be balanced off would be man himself (he would promptly be decimated), for in terms of the biological law of equilibrium man himself has become a veritable plague upon the face of the earth.

"WILD . . . THEORIES"

One so-called "authority" on the "organic way" recently stated in a published book that the development of cancer late in life is induced long before or during the mother's pregnancy, and even earlier perhaps, by her inconsiderate ingestion of foodstuffs treated with additives or fruits and vegetables sprayed with pesticides. From this point he extrapolates his thesis to include the diet of the father also as having a delayed carcinogenic response in the offspring. Surprisingly, the "eminent doctor" failed to seize the opportunity to contend that the most effective anticarcinogen, therefore, would be contraception.

Amusing as some of these wild, and obviously untested, theories of farming are, unfortunately it has now become a very serious matter. The immense strides taken by agricultural science in America have effected a highly significant political shift in the interests and livelihood of the electorate. One hundred years ago one farmer fed himself and three others; today he feeds himself and twenty-four others. These surplus non-agricultural peoples are those who have made our industries, our education, our research and our culture flourish. This has given America its power, but it has also inflated our cities and suburbs and proportionately reduced our rural peoples concerned with farming. The result is that the American farmer is rapidly becoming a political minority by dint of his own industry and competence. At the same time, forces are appearing in our Federal and State legislative bodies which, pressured by uninformed but vociferous groups, are introducing legislation that can contribute virtually nothing to the welfare of our people as a whole and concomitantly severely harass our farmers and impede the progress of our agriculture.

OTHER BILLS ENACTED

The Delaney Clause, discussed above, is a case in point. The Sherman Cooper Bill relating to the use of animals in research is another. There have been similar bills considered and passed by State legislatures, and generally hastily rescinded in confusion. One required a farmer or feed dealer to secure a veterinarian's prescription each time he supplemented a batch of mixed feed with a sulfonamide drug; another required that each crate or box of packed vegetables or fruit would have an adhering sticker that listed all the agricultural chemicals (by generic name) employed in the raising of the crop. As any box of produce from a packing shed could readily represent as many farms as the number of units in the box, the costly impracticality and utter infeasibility of such proposals should be obvious. The mere fact that such are not obvious illustrates vividly the colossal ignorance of practical agriculture that obtains in such legislative quarters.

The one point emphasized by Dr. Emil Mrak, Chairman of the California Special Committee on Public Policy Regarding Agricultural Chemicals, was that throughout the hearings, among urban consumer groups, there was a consistent sense of ignorance and suspicion concerning agricultural chemicals and a consequent distrust of the farmer, the extension man, the college and industrial research worker and of the Federal and State control administrators. This, of course, is revealed repeatedly in the various books, pamphlets, magazine and newspaper articles published on the subject for public consumption. This is the real problem confronting us, and one to which all of us concerned with agriculture should address ourselves with tenacity and vigor. For in a democracy it is essential to let the people know the facts and, having done so, we can rely upon their collective judgment.

There are few people who have a clear concept of the investment in expense, time, effort and facilities by both government and industry involved in the discovery, development and commercial application of a new agricultural chemical.

"ARRANT NONSENSE"

Too many of the general public, including some members of State and Federal legislative bodies, have accepted without question some of the arrant nonsense published in the lay and pseudoscientific press, which implies that new chemicals are dumped into commercial channels without adequate testing for safety, efficacy and economic validity. The immense investment required to meet the established regulations of both Federal and State offices, which currently averages over two million dollars per new compound, is assurance enough that no company is going to be cavalier about the utility or the safety of their product in the market place.

There is a distinct difference between the approach of a college or experiment station and that of a commercial company into the field of agricultural chemistry. The land grant colleges and experiment stations have a specific locale of responsibility within a state, for perhaps a single crop or group of related crops or domestic animals. Their concern is one of specific problems. They look for a method to control the problem, turning to convenient sources available to find the solution. Their approach is, in short, local, specific and intensive.

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THE SCREENING PROCESS

The chemical company, on the other hand, searches for new chemicals and more economic sources of familiar compounds. It screens these chemicals in search of useful activity, and the nature and direction of the screens employed depend upon the market interest and facility of the company in question. If its interests are confined solely to pesticides, it may restrict its screening procedures solely to these objectives. On the other hand, if the company has wide and varied interests, it may retain a central file of all its chemicals and systematically screen them over a wide array of quite unrelated uses.

Each screening test is a carefully researched and statistically calibrated procedure designed to sort out active from inactive candidates with a precision of at least 95 per cent. Any candidate which emerges positive in the primary screen is at once checked in secondary and tertiary screens to confirm its activity and raise the odds for acceptance from 95 per cent to over 99.9 percent. Once a particular activity is established, all its chemical relatives (analogues) are also screened to determine if even more useful related compounds can be found.

Once a positive possible utility among a family of compounds is established, search is then made to determine in what areas of the country and on what product, crop or animal it is likely to be of valid economic use.

Approach is then made to the agricultural college and experiment station staffs who are expert in the particular problem to which the compound appears to be applicable. On the basis of the preliminary utility and safety data, they will decide whether to go to the field with the compound and apply it experimentally under proximate farm conditions. Such field testing usually proceeds simultaneously in as many as a dozen or more areas and over a period of at least two years and often for as long as five years.

Concomitant with these extensive field trials, the company proceeds with research and development of other phases necessary to establish safety, stability, compatability, metabolism, toxicology, formulations, manufacturing process development, and finally market research to determine where, how, when, and in what form to introduce the product into commercial channels.

TWO YEARS IN DEVELOPMENT

After at least two years, and usually more, of this intensive research and development, the entire data sheets are collated into a comprehensive report and submitted to the regulatory offices of the Federal government that are concerned, usually the U.S.D.A. and the F.D.A. Their experts go over the evidence in detail, usually requiring additional evidence of

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safety, utility, control, etc., or further elaboration of that data already submitted. Then, if the government examiners are satisfied that the compound fulfills the legally established requirements in accordance with proposed label claims; that the host plant or animal is adequately tolerant to it; that it is safe for humans to use or consume; that it is practicable to use; that it is stable in storage and distribution in the time and environment of its use; that it is compatible with other materials likely to be used with it; that it can be assayed reliably in its method of use; and finally, that the product is economically valid—then it may be registered.

Only when this roster of regulations is met to the full satisfaction of the government authorities is the product registered and allowed to enter interstate commerce, and then only within the strict confines of its approved label claims and recommendations and within those states whose own regulatory agencies are willing to accept the data as presented to the Federal authorities.

DANGER REDUCED TO MINIMUM

This long and tortuous course is by no means complete, however, when the first label is registered, as it must be, at least in part, repeated for each successive additional use and label claim for which registration is sought. It is obvious that this necessary and accepted restraint upon the evolution of new chemicals for agriculture exerts a massive screening effect that reduces the chances of the emergence of products, dangerous to the consumer, to a minimum.

The fact is that new chemicals are so critically studied and examined before they are released for commercial use that their potential hazards to human health are not only less but better understood than many of those which occur in so-called "natural" foods.

CARCINOGENS IN "NATURAL" FOODS

One of the major themes constantly recurring in the literature opposed to agricultural chemicals contends that only "natural" compounds are safe and only "natural" controls of pests and diseases are really effective. The argument that only "naturally grown food-stuffs" (whatever that means) are safe for human consumption because nature ensures that they will be free from carcinogens, toxins, allergins, goitrogens, adverse enzymes, etc., is completely in error.

There are, in fact, a whole array of well-accepted and long-used "natural" foods which are now known to contain appreciable amounts of suspect carcinogens, and doubtless many more will become known as food chemistry advances. A few familiar examples are tannic acid in tea, in nuts and in many fruits; capsicum in peppers; thio-urea derivatives in virtually all cole crops; arsenic in shell fish; selenium in many cereals, fruits and vegetables (which incidentally is quite possibly an essential nutrient element for all warm-blooded animals, including man); cobalt in all meats (also a major component of vitamin B_{12} essential for blood formation); iron found in virtually all foods (and a component of human blood); estrogens found in all meats and also in humans.

Whether such substances induce carcinomas or not depends, of course, upon a number of other factors, the principal one of which is dosage intake versus metabolism and elimination rate. Similar consideration applies to all agricultural chemicals.

It is frequently argued that pesticide and feed supplement residues are objectionable even in minute amounts as they may induce allergies, yet innumerable natural foods induce allergy in man. Such common foodstuffs as cow's milk, eggs, fish, particularly shell fish, pork, chicken, cheeses, wheat, corn and a wide variety of fruits and vegetables are authentically recorded as allergenic in man under certain conditions, regardless of whether they have been treated with agricultural chemicals or not.

There is also a wide variety of cyanogenetic (cyanide producing) compounds found in the seeds of almond, peach, plum, apricot, cherry, apple and pear; also in lima beans and java beans and, of course, in the Christmas treat marzipan; and in many animal fodders such as sorghum and grasses (Johnson, Sudan, Bermuda and arrow), in white clover and linseed cake.

Again there are natural foods which contain anti-enzymes that can readily induce vitamin deficiencies when consumed in excess. Examples include avidin from raw egg white, which produces biotin deficiency, thiaminase in certain fish produces vitamin B_1 deficiency (beriberi); pellagrogen in corn meal induced a widespread condition of pellagra among the poorer peoples of the Southern states until it was recognized as a niacin deficiency.

Among animals dicumarol in certain clover hays induces vitamin K deficiency and hemorrhage, while unsaturated fats in the diet of poultry may induce encephalomalacia which is controllable with dietary vitamin E. Linseed oil meal fed in excess can induce a vitamin B_6 (pyridoxine) deficiency.

THE "CRANBERRY BOGGLE"

During the "cranberry boggle" of 1959, the industry was virtually ruined because it was alleged that part of the crop had been "sprayed with a violent carcinogen." Actually the experimental evidence accumulated both before and since the incident indicates that the accused compound is not a carcinogen but a goitrogen, a chemical which will cause the thyroid gland to enlarge, presumably by preventing the gland from absorbing

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sufficient iodine. The effect has been found to be completely reversible by removing the compound from the diet, a fact, incidentally, which should be sufficient to also remove it from the carcinogen list. Furthermore, the maximum amount of residue found on the cranberries, a small number of which had admittedly been illegally sprayed (in violation of label instructions, incidentally), was of such magnitude as to require the daily consumption of some 15,000 pounds of raw cranberries for over ten years to provide a goitrogenic dose in man. This would have been a prodigious gastronomic feat even for Paul Bunyan.

However, a much simpler way to secure appreciable levels of goitrogen, if so inclined, is to turn to "natural" sources with a diet well fortified with turnips, kale, cauliflower, peanuts, soybeans, mustard, beets, peas, beans, spinach, lettuce, carrots, celery, chard, green peppers, filberts, pears, strawberries, peaches, apricots, raisins, milk, oysters, clams and, that epitome of all natural food lovers, raw liver. The list looks like a recipe from a book on "organic gardening," but be sure not to cook any of the items: it destroys the active principal.

CONTROL OF INSECTS

Biological control of insects, parasites and diseases is admittedly the ideal method of control; however, it is highly specific, too late, too slow, too uncertain and too costly. Nevertheless in certain specific areas it has been significantly successful. The milky disease control of Japanese beetle, the irradiation sterilizing of male screw worm flies, the use of lady beetle (coccinella) larvae to control alfalfa aphids in the valley pockets of the Western mountains, and spraying or dusting the spores of *Bacillus thuringiensis* for control of certain moth and butterfly larvae are all good examples of effective biological control. However, each is quite limited in the scope of its use and efficacy.

The grower, however, is confronted with a whole array of pests, insects and acarids, fungal and bacterial diseases, parasites and weeds, several species of which may attack his crop or animal herd simultaneously or sequentially during its production life. Control of one pest and none of the others, or even control of all but one, is often as futile as controlling none.

Federal and State authorities require the farmers' products to be free from insect blemish and disease, to be of specified grade size and conformity for interstate shipment his animals must be free from contagious disease, vermin and parasites to pass meat inspection department standards. He therefore cannot, indeed he must not, fall below the rigid requirements of grade and quality. Furthermore, the processor who packs the grower's raw product is obliged to meet label specifications rigidly if he proposes to ship in interstate commerce.

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"ORGANIC FARMING" IN CHINA

The grower must, therefore, exercise precise and exact control over *all* the pests that plague his crops all the time. How he can be expected to do this without agricultural chemicals is, of course, a point the "organic school" answers by maintaining that if the grower only used organic manures (no "hideous" chemical fertilizers), if he allowed the birds to eat the few, very few, insects that would deign to attack "organically grown" crops, if he would throw away his pesticides and behemoth monstrous spray rigs, if he would just go back to "nature" and become "organic," he would have no troubles with his crops at all. This is, in fact, quite true of course, but only for the reason that he would have no crops at all—e.g., China, which has tried to grow crops "organically" for five thousand years and lives on the edge of starvation to this very day.

The farmer is therefore caught between the rigid rules of product grade, quality and uniformity laid down by the marketing administrations, Federal and State, on the one hand, and increasingly stringent limitations on the use of agricultural chemicals on the other, with no sensible, constructive alternative offered to relieve the encircling pressures.

There have been a number of reviews of the problem by competent committees and authorities, both Federal and State, in recent months. All have carefully considered the pros and cons of the relative value of the use of agricultural chemicals versus the alleged dangers to public health and wildlife conservation, and without exception these qualified groups have reported that food production and the nutritional living standards of Americans could not obtain if agricultural chemicals were abolished. Each group recognizes the potential hazards involved in the widespread use of certain pesticides but concedes the standard procedures worked out by Federal and State authorities in collaboration with industry are adequate and safe when such pesticides are employed in strict accord with approved label recommendations.

THE REAL PROBLEM

Unfortunately, most of these excellent reports are read mainly by technical agriculturists who are virtually in complete unanimity with one another as to the controlled and necessary use of agricultural chemicals. The real problem lies in bringing a sense of proportion and understanding to the general public on the necessary use of agricultural chemicals in the production of foodstuffs; in re-establishing public trust and confidence in the reliability and sincerity of agricultural research workers and administrative officials in the government departments, colleges, experiment stations and industry; and in convincing the consumer that the bright array of foodstuffs offered in the retail markets of America today is the

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most nutritious, wholesome, safe and economic (21¢ of the take-home dollar) of any country in the world.

This message must be hammered home in a thousand ways in a thousand places, and be given simply and factually in understandable terms and with sincere conviction.

For we do not have much time to prevaricate and to dissemble with our food supply; we have guests coming to dinner on New Year's Day 2000, nearly 400 million of them.

Defendant N.Y. Times PP 1066 e

THE ROLE OF PESTICIDES IN FOOD PRODUCTION AND HEALTH

cf: p926.

Robert White-Stevens
Agricultural Division
American Cyanamid Company
Princeton, New Jersey

In the latter third of the Twentieth Century, which commenced incidently just this last fall, our nation and the world as a whole has entered upon the most challenging period in the history of mankind. We have only about thirty years remaining to meet and resolve the immense problem of feeding and sheltering a human population which will inexorably pass six billion and quite possibly seven billion by the year 2000 A.D.

With over two-thirds of the people present on earth today in a state of malnutrition and over half virtually at starvation level, the inevitable doubling of the population in the next thirty years can only result in a socio-political economic disaster of catastrophic proportions. Such a debacle in what we have come to regard as modern civilization will not suddenly occur like a bolt of lightning, but will appear, as Anson points out, here and there in patches, like festering sores, which will coalesce into vast areas of suffering the effects of which ultimately will extend into every quarter of the planet.

The incredible increase in humanity in the Twentieth Century which will aggregate more than three-fold the entire growth of mankind since humanoids first appeared on earth, is undoubtedly the most cataclysmic biological event since life first appeared on the planet. Man today is probably the most prolific mammal in existence and certainly exceeds the entire aggregate of his mammalian livestock.

Presented before the Southern Pesticide Applicators
School of USDA Coop Ext. Serv. with Texas A & M Univ

The total emigration of Europeans to the Western Hemisphere over the past three hundred years is now roughly equalled by the annual increase in world population. This movement of the European peoples into North and South America, not foreseen by Malthus in his essays on population and food written almost two centuries ago, relieved the press of people in western Europe and is now virtually completed. The total of massive emigrations that are perhaps still feasible into the Western Hemisphere, Oceania and the sparse, inhospitable reaches of Russian Siberia could only accommodate the additional population of one, two or at the most three years of increase at the present rate, which is itself rising in compound interest terms.

Grain Production, the Indicator

In 1960, as Brown points out, the curve for world grain production was crossed by that for grain consumption, and unless measures are immediately taken to turn the production of grain sharply upward, the resulting stock "draw down" will convert the burden of surplus, so maligned in the 1950's, into a world-wide deficit by the 1970's. As grain is basic to all food production its balance of supply and demand is reflected in availability of all food everywhere, and it serves as a sensitive indicator in the total relation of population to food supply.

In western Europe during this present decade grain production has risen 2 1/2% per annum, while the population is increasing at only 1% per annum. This is substantial progress and has been reflected in a concomitant rise in the European economy. In Latin America there has also been an annual grain increase of 2 1/2%, a surprising achievement, however the population is climbing at 3% annually resulting in a net loss in general economic status. Around the world as a whole the net nutritional gap is widening at an alarming rate particularly with respect to protein supply. At the current population growth 35% increase in total food production will be required to maintain the present clearly inadequate diets, and a 50% increase is necessary to bring the total human diet to the minimum calorie-protein requirements established by WHO of the United Nations.

The Alternative to Required Food Increase - Chaos

To maintain such minimal diets through year 2000, total world food supply must be trebled, while among the underdeveloped nations where the deficiency is already acute, food production must be quadrupled and animal protein in particular increased six-fold.

Can these levels be reached by 2000? If so, how? This is the great challenge of our time and as we in scientific agriculture have the knowledge and the tools with which to achieve these goals it becomes our duty to do so.

Senator McGovern, in a recent article, raised the provocative question, "Shall we in America today be remembered, in the years to come, as the nation that preferred to expend their talents, their treasure and their opportunities upon sending a man to the moon rather than turning our knowledge, our power and our compassion upon the needs of mankind?"

Thucydides some 2500 years ago remarked, "Those who fail to learn the lessons of history are condemned to live it over again," yet modern man, despite his conquest of hunger in the Western World may again fail to note the lessons of history and apply his knowledge and power to satiate the the needs of his people and like so many preceding civilizations in the past descend once more into oblivion.

Food, the Basis of All Civilization

For starving people are apathetic; they lack energy and cannot work productively or efficiently; without work no products are produced and no products yield no income; without income capital investment is futile; without capital no start on the problem can be initiated. These submarginal peoples, to whom Malthus himself referred as "those, who in the great lottery of life, have drawn a blank," essentially lie beyond the pale of our society and outside the economic bloodstream of mankind. They are no more economically significant than are the wild creatures of the forest or plain, they neither add to nor detract from the course of world economy; but they are human beings and as such exert enormous social and political significance which in the close quarters of the world today modern civilization can no longer afford to ignore. They can and must be nourished, educated to primary literacy and put to work to produce their own food and fiber, to earn real income in goods and services which they can exchange for currency and other products from abroad. Then they will create new desires, new needs and new markets which can be supplied by industry and the vicious cycle of hunger, despair and want will be broken and the "take-off" stage reached.

Steps Needed to Increase Food Supply

The primary need is food and fiber and the first step that can be made is in gathering the maximum harvest possible within the scope of present practise and facilities, in preserving the harvested produce and in distributing it to wherever it is needed. In India for example Dr. Subramanyan of the Institute for Food Research at Mysore reports that over 50% of the food gathered from their very poor harvests fails to reach the desperately hungry because of the ravages of insects, disease and vermin. In India it would be possible immediately to increase the use of food now produced by almost 100% by merely protecting it, a function for which pesticides are largely designed. In addition harvested yields are absurdly low due to poor soil management, nutrient deficiency, insects, diseases, weeds and drought. Again within the present Indian farming procedures introduction of simple machinery to prepare the seed bed, modest dressings of as little as 300-500 lbs. of 5-10-5 equivalent fertilizer plus 500-1000 lbs. of lime per acre which would show substantial increases in yields, together with insecticides, fungicides and particularly herbicides and the simple hand equipment needed for their application, would, it is estimated, increase yields from 50-100% within 3-5 years. This might well be enough head start to lift many Indian farmers into the "take-off" stage, where they could then advance themselves to more effective plant and animal stocks, heavier equipment more agricultural chemicals and efficient storage and holding facilities.

Organized education, extension and demonstration become an essential part of this program, and the emphasis throughout must be self-help, self-production and self-achievement for only then will they develop pride in their work and their goals can be attained with astonishing rapidity. This is not an idle Utopian dream for Japan and Israel have already accomplished such objectives under perhaps even more difficult circumstances than those which today confront India.

The Role of the United States in the War on Hunger

The role that the Western World, particularly North America, will play on this attack on starvation will be in three phases:

First Phase - The filling of the gap for food deficient nations for the interim period of perhaps 5, 10 or even twenty years before the emerging nations can become fully self-sufficient. This will generate an enormous market for our farm proudcts, in turn creating strong demand for all agricultural inputs such as machinery, plant seed, animal stocks and chemicals. There will be some resistance initially to such an expansion of our agriculture for fear that food surpluses will again accumulate as the developing nations replace our food supply with their home grown produce. Although there may be some temporary surpluses of grain, soybeans, etc. these will be quite fleeting and with well planned scheduling they will not be of great economic significance. For we would export to needy nations primarily cereals, legumes and corn, which we can always condense into higher priced luxury animal proteins for our domestic market and for Europe whenever the supply of cereals exceeds the demand. In addition our own population will increase by at least 150 million during the next thirty-three years and in the 1980's we will readily consume any such surplus production potential from the 1970's developed to aid emerging nations through their first phase.

Second Phase - The emerging nations will need to educate and train their rural peoples to primary literacy, to train them in the elements of modern agriculture, to supply them with equipment, plant and animal stocks applicable to their region together with agricultural chemicals, to provide local elementary training centers with ancillary extension service similar to our own county agent system and to establish regional experiment stations and laboratories to resolve local problems. Here again the western countries will need to supply the equipment, the chemicals and initially the instructors to start the training of native teachers and to initiate the program. Within thirty years the emerging nations could take over the entire program of education, extension, field research and development and become self-sufficient.

Third Phase - With their people adequately fed and their lands productive the governments of these emerging nations can then embark on major projects involving irrigation, power production, light industry, improved transport and ultimately, where resources and markets permit heavy industry.

Actually each phase would merge into the next with no clear line of demarkation. Some areas within each nation will advance more rapidly through the phases than others.

Combined with such a program there will have to be some form of organized population limitation, preferably on a voluntary basis promoted through education, for no food production program, regardless of how efficient it may be can possibly keep pace with an exponentially expanding population. This is the major challenge and duty of the medical profession, the social scientists and particularly the politicians.

North America, the Last Great Hope on Earth

Precisely which form the program to meet the food and fiber needs of mankind will take in this last third of the Twentieth Century is as yet uncertain but one paramount fact is clear. The United States and Canada are about to meet the greatest demands both from at home and abroad on their ability to produce food in their history. The need will be immense for agricultural chemicals, for fertilizers and feed supplements to promote production of plant crops and livestock and for pesticides to suppress the incursions of predators and parasites upon the produced crops and animals both in the field and on the derived processed foodstuffs in distribution channels and in storage.

With this demand which can easily double the domestic market at home within a decade and double it again around the world, will come an increased pressure for pesticides that are effective, safe, practicable, stable, correctly formulated and packaged, economically valid and efficiently applied.

Pesticides, an Essential Factor

There may well be vast changes ahead in the control of insects, diseases and weeds, but it is quite certain that all such changes will involve the increased use rather than reduced application of pesticides.

In spite of the recent carping and criticism directed at the use of agricultural chemicals in the production of the nation's food and fiber and the maintenance of the public health, the indisputable fact remains that without these powerful instruments modern agriculture as now practised

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would be completely impossible. From 80 to 100 million people in North America simply could not be fed if we had to rely upon biological controls to preserve our crops, our livestock and our stored foods and fibers. Our standard of living would decline to intolerable levels and we would be unable to bring relief and succor to any other nation on earth. The destitution, disease and devastation that would descend upon every quarter of mankind would be virtually indescribable.

There will be, undoubtedly, many specific programs of pest control, particularly of insects, which will involve integration of biological with chemical control methods. Indeed this has been the general basis of control long before the advent of modern pesticides. Plowing down crop detritus to reduce carry-over of wintering spores, eggs or pupae, rotation of crops to hold down pest multiplication, destruction of alternate hosts, delayed seeding dates to escape infestation, release of predators, use of resistant varieties, plant location and spacing to avoid favorable pest environments, fertilizing and irrigating to reduce pest invasion all comprise biological control in the broadest sense.

Furtick points out that many of our present cultural methods were originally designed solely to reduce the competition of weeds. The two-way check row system of planting corn, for example, was designed primarily to allow for adequate control of weeds by cultivation, and the width of the rows and checks was based on the size of the rear end of the horse that would pull the cultivator. Now the introduction of the new herbicides entirely eliminates the need to cultivate some crops and has induced agronomists and practical growers to re-assess the spacing in many field crops in relation to optimum yields. Furtick contends it may well prove to be more efficient to grow many crops in virtually solid plantings like cereals rather than in rows, provided weeds, insects and diseases can be controlled either by preplanting or pre-emergent applications of systemic pesticides or by topical treatment from the air or in irrigation waters over the growing crop.

Certainly when our major crops can be successfully raised in an essentially weed-free environment, when our rangelands and pastures can be rid of the mesquite, unpalatable shrubs and non-nutritious herbs and grasses which predominate the vast reaches of our plains then the productivity of cattle, sheep and wildlife also will flourish. With the new herbicides available today we can now begin to realize this, and around the world the impact it would have on grazing animal production is immeasurable.

Biological Pest Control Only a Partial Answer

There will undoubtedly be an expansion of broad Federal and State programs to reduce insect pest populations by such biological methods as sex sterilization, attractants and predator release but these are highly specific and though they may materially aid the grower in reduction of pest contagion they do not offer his crop the total protection he must have to meet the demands of his market.

The grower must bring his produce and his livestock to market virtually unscarred and unblemished if he wishes to receive top price. Indeed in many cases he cannot market his crop at all if he does not meet twenty-three of twenty-five pests he might as well knock off the other two en route - he would anyway.

The Fallacy of the Target Pesticide

There has been much said in recent years about target pesticides. The argument advanced, in some cases by those who surely must know better, is that we should use a pesticide specific only to a single insect or at least to a closely related family of insects, such for example as the aphids. Such a pesticide would therefore kill only that particular bug and no other. In this manner it is claimed we would not harm beneficial insects or wildlife and thus not upset the so-called balance of nature. As expressed in a recent book we would "kill with a stiletto rather than a club."

The fallacy in this reasoning lies in the complete disregard of its impracticality. The Virginia apple grower, for example, would need to stock twenty-five different pesticides in adequate quantity and formulation. As many of these pesticides would require different methods of application he would also have to purchase several different types of equipment and keep them in working shape. He would have to be able to identify immediately each pest as it arrived and recognize the precise stage at which the specific pesticide should be applied. Finally, he would have to be well versed in chemistry in addition to horticulture, entomology and plant pathology so that he would know which chemicals can be mixed together or applied upon each other.

As all pests do not come singly and sequentially but in bursts of several at a time this grower might well find it necessary to go through his orchard two or three times a day applying first one chemical then another to catch each specific insect or disease in turn. Not only would this become fantastically impractical and costly, but he would rapidly wear out his equipment, abuse his trees and literally run himself into bankruptcy.

The probability of such a grower being able to thread his way through a season of such complex pest controls is so extreme that certainly any apple producer who successfully completed such an obstacle course would be entitled to at least $2 apiece for his apples, a price the urban house wife would likely be quite reluctant to pay.

In addition to this absurd predicament for the grower there are equally rediculous burdens such a target chemical proposal would lay upon the pesticide manufacturer and the State and Federal food control officials.

The manufacturer would have to invest essentially as much time, effort and facilities in researching, developing, formulating, registering and marketing a pesticide with but a single label claim as one which carried a hundred claims and uses. His prospective market however, would obviously be substantially limited, under present requirements for registration, to a point where recovery of investment would be a virtual impossibility. Furthermore, as formulations for various host plants often must differ it would be necessary to develop, manufacture, control, package, inventory and market a single pesticide in multiple formulations for a single pest for a single crop use.

The problems for the State and Federal control officials would also proliferate to prodigious levels as the application of twenty-five different chemicals to a single crop of apples would create insuperable difficulties in the monitoring of residues, and the number of pesticides needed to combat all the pests on all the crops in all the crop areas of the country would aggregate tens of thousands and require a staff of chemists several orders of magnitude from that of the present.

From these obstacles, plus the fact that it is quite dubious that it would be possible to develop a target specific pesticide for even every major pest, it is obvious such a proposal is completely absurd. It is true one or two such target pesticides have evolved, presumably more by accident than by intent. One is the remarkable compound RATICATE(R) -norbormide(5-(alpha-hydroxy-alpha-2-pyridylbenzyl)-7-(alpha-2-pyridylbenzylidene)-5-norbornene-2, 3-dicarboximide) which is apparently an absolutely specific poison to the Norway rat. Another is one Cyanamid has found and developed called ABATE(R) (0,0,0',0'-tetramethyl 0,0'-thiodi-p-phenylene phosphorothioate) which is highly specific to mosquito larvae. There may be other possible uses for this interesting phosphate insecticide and we are diligently searching for them, but at the moment, at least, it is registered only for mosquito abatement.

Objectives of the Agricultural Chemical Industry

The objective of the Agricultural Chemical industry is to find, develop and apply compounds which will be active in economical and practical formulations at sensible levels in dosages safe to the applicator, the host plant or livestock, the consumer of the treated product and to desirable wildlife; but at the same time with as wide a spectrum of activity against the pests as feasible. This applies primarily to insecticides and fungicides. With herbicides high target specificity is obviously highly desirable and useful.

Actually the newer pesticides do show a widening margin of safety at the effective pesticidal levels between invertebrates and vertebrates. The newer systemic pesticides, in addition, effectively discriminate between pests and beneficial insects for they only kill those which actually attack (bite, suck or chew) the host plant.

Industrial Research and Development of New Pesticides

The research and development of a new pesticide either for use on plant crops, livestock, waters, forests, rangelands or area control has evolved into a highly organized program involving a wide array of scientific disciplines, equipment and facilities. These are usually not directed at a specific pest but at general areas of problems, at least in the initial stages of a project. For it would be unwise for a company to select, for example, the European corn borer as a target, and marshal its staff and facilities for the sole purpose of isolating a compound effective specifically against this pest. Such would be an extraordinarily expensive, risky and probably economically futile course to pursue. It would be comparable to buying an automobile that could only go north or south and another only east and west, both being expensively useless.

Most chemical companies isolate new compounds from natural sources such as plants, soils, fungi, bacteria and animals or they synthesize them from other known compounds. These are then tested through a series of screens to determine their potential usefulness in medicine, in agriculture or in industry. When prospective utility appears then a more intensive screening is applied to delineate the precise nature both qualitatively and quantitatively for such possible application. Should a particular compound show interesting activity as an insecticide then of course a number of near relatives, or analogues, are also prepared to determine the scope of the activity in terms of molecular structure, and, hopefully, to find a particular analogue even more effective and useful than the original lead compound.

Following two or three years of intensive laboratory study, if the selected compound appears to hold up in crucial testing, then the synthesis is scaled up from grams to pounds and samples extended to the land grant colleges and experiment stations for field testing in areas where the pest sensitive to the compound is known to be endemic. Preliminary toxicology is first carried out to determine the toxicity of the new substance and to prepare necessary precautions for people who will research it further in the laboratory or the field. If after a year or two of field testing, the supreme court before which many new pesticides fail, the compound continues to appear useful, then the company begins intensive research to develop methods of assay both of the compound as formulated and of its possible metabolites or residues in the treated plant or animal; formulations are developed; long-term toxicology in two species of mammals is commenced to determine any possible injury that might result from consuming the compound; and studies into the fate of the compound in or on plants, animals or soil are carried out to determine precisely what happens to it after it is applied.

These studies together with those proceeding concomitantly at the field experiment stations usually go forward for at least 4-5 years and often to eight years. At any time during this long gestation period should some unexpected undesirable feature appear, such as serious side effects among the test animals on toxicity trials, instability of the compound in storage, explosive properties, phytotoxicity, excessive corrosiveness, etc. the product is promptly withdrawn and the project terminated.

When it is felt the evidence accumulated shows the pesticide to be safe, useful, economically valid and effective then the data are carefully collated into a report and submitted to the USDA for review of the efficacy evidence and to the FDA for review of the safety data. When all requirements are met then the new pesticide may be registered and a label claim allowed relative to the specific evidence provided. Each additional label claim must in turn be supported by equivalent and pertinent evidence.

Thus the entire course from invention to registration may occupy 8-10 years and represent an investment of from 2 to 3 million dollars.

The Pesticide Label - Industry's Ultimate Responsibility

The touchstone of this investment is the label which represents not only the condensed expression of eight years of intensive research and investigation by as many as 20-30 highly qualified experts but more importantly constitutes the instruction to and protection of the farmer who applies the pesticide and the consumer who without knowing anything at all about the compound eats the treated product.

It is obvious that in our complex society where foods may derive from many areas and become mixed or processed together that such public regulation broadly applied over'all foods and compounds used in their production or preparation is essential. The consumer cannot possibly protect himself in such a complex for he has no knowledge where, or how or with what the food he buys has been treated, so he assumes in good faith it is safe to eat and that the government is indeed protecting his interests. Actually, of course, the State and Federal authorities can only set up the rules and standards and by random inspection and sampling maintain reasonable monitor on each kind of product from each major area. They cannot hope to check every product from every area all the time and the only real assurance the consumer can have as to the quality and safety of a product he may purchase lies in the integrity and responsibility of the producer. In turn this sense of probity is derived by the producer from those who supplied him with the raw goods and materials from which he made his product. This includes his source of pesticide and those who formulated and who helped to apply it.

Thus the manufacturer of a pesticide who after investing eight years of time and upwards of 2 million dollars in capital in his product would indeed be extraordinarily foolish if he failed to ensure in every possible way that his product would fulfill the needs, not only of his customer, but also of his customer's customers.

Importance of Formulations and Application

Regardless of the efficacy, safety, stability, versatility or economy that the manufacturer may build into a new pesticide it can often be diminished by unsuitable inefficient or inaccurate formulation or by inept and inefficient application of the pesticide in the field. Although it is true that no amount of good formulation or application can make an effective pesticide out of an inactive compound, it is also a fact that poor formulation or incompetent application can certainly impair the efficacy of an active pesticide. Just as the classical definition of an economic product is one that is in the form required, at the place required, at the time required and at the price required, so is a pesticide effective when it has the requisite activity, and safety, is formulated properly, is stable and is applied precisely where it can effect its required activity.

Only in recent years have we come to appreciate the importance of formulations and the method of application. Improved carriers, emulsifiers, spreaders, stabilizers and potentiators have all enhanced the efficacy of our pesticidal compounds substantially. This has proved to be a two-fold benefit. First, it has provided a more effective pesticide from which we now can get more mileage, but in addition it has, in many cases, widened the safety margin between the pest and man and animals.

The development of granular formulations with sustained release has materially improved the efficiency of the systemic insecticides and particularly the herbicides used for selective weed control in cereal plantings and rangeland or pasture management. Improved liquid emulsifiable concentrates, wettable powders and immiscible solutions ensure more uniform spread, prolonged adhesiveness and are particularly more adaptable to the variety of equipment and methods of application now available to the grower.

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Developments in Application

Although ground equipment still comprises the chief route of application on most crop plantings, as individual farms increase in area, as single orchards and vegetable fields become more extensive and as drilled crops, such as cereals, inaccessible forests and vast pasture and rangelands require pest control such relatively low-gear ground applicators become either impractical or uneconomical.

The use of aerial equipment planes, helicopters and the more recent air cushion applicators has and will continue to increase. Early attempts to apply pesticides from the air were fraught with complications and often with dissappointing results. Indeed perhaps the most violent criticism of the use of pesticides was primarily directed at aerial application. It was frequently contended, and admittedly with some justification, that the aerial application was largely a clumsy operation that lacked precision. It was considered, in short, to be the epitome of the indiscriminate use of pesticides. Drift, ununiform distribution, contamination of lakes, streams, waterways and even private property were repeatedly cited in opposition to aerial application of pesticides even of quite restricted areas. This opposition understandably crystallized into legislation strictly controlling the kinds and levels of pesticides that were allowable for aerial application, the type of equipment permissible and defined the precise conditions of weather during which spraying could be done. These regulations have reached the point in some states, such as California, where custom applicators must be examined and suitably qualified, and where each and every application must be registered with the county agricultural commissioner as to all details of where, how, when and with what a particular area will be sprayed before license to make the application is issued. In intensive crop areas as the San Joaquin Valley of California such absolute control is essential for the general protection of all farming areas, for irrigation canals could easily carry compounds to sensitive crops miles away from the site of treatment with serious results.

The recent development by the USDA of low-volume aerial application of insecticide constitutes a significant breakthrough in the whole scope of pesticidal treatment from the air. It was noted that concentrated solutions of the insecticide could be applied more uniformly with greater penetration into the plant canopy, with less drift and less evaporation than the conventional water diluted and dispersed emulsions. In addition substantial economies in the cost of application accrued as the area per payload increased 6-10 fold, with a concomitant reduction in fuel costs, reloading time and service expense. As drift was reduced the planes could fly four to five times as high above the canopy, providing a wider swath per pass and more importantly greater safety to the operator and neighboring people.

New pumping systems were devised to meter the pesticide accurately in ounces instead of gallons per acre, and also to provide virtually instantaneous cut-off control; special distributor nozzles were developed to spread the minute levels of the pesticide into swaths of controllable fine particles.

To date the bulk of the field trials have been carried out using the insecticide, Malathion, but there is every reason to believe that fungicides and herbicides as well as other insecticides can be prepared and adapted to the same principle of low-volume application.

There is considerable field investigation proceeding to adapt the L.V. method to ground equipment, where also considerable practical and economic advantage over conventional methods is anticipated.

A recent study has been initiated, stimulated presumably by the needs in the Viet Nam conflict, to apply pesticides, both insecticides and herbicides by the LV. technique at vastly greater heights (to avoid ground fire) than any regarded as suitable for crop, forest or rangeland treatment in this country.

Such improved efficiency in application of pesticides, together with more effective formulations and pesticidal compounds with superior activity and wider margins of safety all integrate into an increased capacity for modern man to meet his rising needs of food, fiber and public health.

The Importance of Pesticides Confirmed

In spite of the fierce criticism which assailed the agricultural chemical industry and the whole apparatus of pesticide utilization during the past five years the quiet assurance of those of us actively familiar with these instruments of modern agriculture has been reaffirmed and substantiated. There was never any doubt in our minds as to the relative benefit and hazard of insecticides, fungicides, herbicides and rodenticides. We knew from the start that, without them, this country could neither feed the bodies nor sustain the health of its people. We knew that if the present take of insects, disease, tares and rodents of some 20-25 cents of the food dollar were allowed to increase to 40, 50 or perhaps 75 cents as it is in India today, not only would our food standards precipitously decline but the quantity available would drop to below subsistence level. We knew that diseases such as malaria, yellow fever and typhus which scourged our people mercilessly for two centuries and which still hold great multitudes of humanity prostrate, would once again return to our shores after having been extirpated and banished for over a decade.

Now that the emotion and mindless carping has largely subsided, and after a dozen or more State and Federal committee reports have been issued the public realizes that the possible dangers of pesticides are understandable, assessable and therefore controllable while the perils they prevent are ubiquitous, unpredictable and devastating.

Pesticide Hazards Exaggerated

Even so there still appear spurious tracts and articles, obviously more attentive to circulation than veracity, which deliberately continue to seek to foment fear and consternation among the public over the exaggerated dangers of pesticides. In the current issue of a popular science magazine an article again reiterates the totally unfounded implication that pesticide residues, specifically the organo chlorines, are "the sinister companions of radio active nuclear fall-out." This type of pseudo scientific mixed metaphor can only be contradicted by experimental objective evidence of which there is, fortunately, an abundance.

The Hayes, Simmons, Knipling monograph on DDT, published in the early 1960's, and incidently completely ignored by Longgood, Herber, Carson, Hueper and other self-appointed custodians of the public welfare, is the most exhaustive and complete documented collation of the scientific literature prior to 1961. There it is clearly indicated that relatively persistent, and usefully so, as is DDT it has a measurable half life in the biosphere which reduces recommended applications below pharmacologically significant levels quite rapidly. The authors clearly annotated that even immediately following normal rates of application deposited concentrations of DDT are generally innocuous to virtually all forms of vertebrate wildlife including birds, with the possible exception of certain species of fish. When one stacks up the injury to humans that encephalitis can do where uncontrolled mosquitoes are allowed to spread it at large, one is tempted to ask how many human babies is a mud puppy worth.

Hayes' long-term studies on the effects of continuously ingested DDT by human volunteers clearly showed that chronic dosing at levels from 20 to 40 times the maximum allowable residues in our foodstuffs, and some 900 times higher than the average intake level in 1962, elicited no measurable clinical effects. Since these classical trials the FDA has repeatedly made market basket surveys in numbers of cities to assess the probable total intake of organo chlorine residues from all sources and finds the total remains below 1% of the allowable tolerance. Corresponding assays of DDT and related chlorinated hydrocarbons in human fat, where it tends to pool, show no increase in storage over the past fifteen years, again giving the lie to the ominous and unfounded predictions made a few years ago and still implied in popular articles today.

The ~~inexpiable~~ inexplicable furor over the Mississippi River fish kill is perhaps as good an example as any of how inexorably fact treads upon the footsteps of fancy. The first notice issued to the press was that the kill was caused by surface wash off and drainage of the pesticide treated cotton fields of the Delta; but when it was shown the primary drainage and tributary streams carried a level of organo chlorine actually lower than did the main river, the cotton farmers became exonerated, albeit in the back pages of the press. Then a pesticide manufacturer near Memphis was accused as the culprit, but the fact that the kill took place some 700 miles downstream promptly downed that explanation. Furthermore, there was no reported severe kill of shrimp and the shrimp, being more closely related to insects than to fish, would have been virtually extinguished if the fish kill had actually been due to chlorinated hydrocarbon pesticides.

Ferguson at the University of Mississippi examined the tolerance of Mississippi fish to various organo chlorines and found they survived at levels over a 1000-fold that measured in the water of the main river.

Later a more logical explanation was the overwhelming invasion of the area by a gill disease which is particularly injurious to bottom fish.

Since the days of the Mississippi fish paralogism the USDA has been carefully monitoring the waters of the main stream and the soil detritus beneath and to date they find no evidence of a sinister accumulation of lethal pesticides.

Perhaps the most curious denouement of the whole fiasco was that at the very time of the wide and fearsome publicity on alledged pesticidal fish kill in the Mississippi River, the USPHS published an official report on the unnatural fish kill in the U.S. and ascribed a shade of 1% of the total nationwide loss to pesticides. In one year they noted improper processed sewage was responsible for over 50% of the recorded unnatural fish kill - 50 times that ascribed to pesticides.

Despite the extravagant claims that pesticides are steadily draining away our wildlife, particularly birds, there is abundant evidence from all areas of the country that wildlife especially bird life is flourishing. The annual Audubon Christmas bird count, described by its founder Dr. Cruikshank as the most complete and reliable bird census in the world, and whose recorders Carson referred to as "having an unparalleled knowledge of bird life in America" shows no general decline in bird life.

Precise animal count data on a large scale in the Yosemite Mountains to assess the impact of general spraying of Malathion to control an invasion of the lodge pole pine needle miner revealed only a momentary (30 day) but insignificant reduction in birds following the spraying, with a subsequent return of even greater numbers of birds within a year.

Although it has not been critically assessed the available evidence to date would suggest that bird life in general may be actually increased rather than destroyed by the protection provided by generalized forest and rangeland spraying of pesticides as a consequence of the resultant reduction of insect vectored avian diseases and the maintenance of the verdure for feeding and nesting facilities.

Agricultural Chemistry - the Key to Future Abundance

As we approach the turn of the second millenium we must prepare for the burgeoning human population that is unlikely to be stabilized this side of 7 billion people. If our civilization and socio-political organization is to be sustained and hopefully improved we shall have to provide food and shelter and health for these billions or only chaos will prevail. Chemistry is the key to the provision of the necessary abundance of fruits of the earth in terms of conventional farming and particularly will chemistry guide us in the very likely event that we must turn also to such unconventional methods of food production as aquiculture - the culture of plants and fish in the marine and inland waters - fermentations of waste sources of energy such as foliage, sawdust, bagasse, cannery wastes, petroleum waxes and even sewage wastes and perhaps ultimately should we need to synthesize fats, carbohydrates and elementary proteins from atmospheric elemental sources.

One inescapable fact is certain, although the challenge to our generation is vast and global in extent and although the time remaining to meet it is rapidly expiring, it is not insuperable for we now have the equipment, the facilities, the materials and above all the knowledge to fulfill this great task. Should we become inclined to dissolve in a council of despair we might once again turn to the words and thoughts of Thomas Malthus, which after two centuries remain tenable and perhaps more confident in tone than does our own philosophy of today.

"At Nature's mighty feast, none are bishops, but all are men; there is no distinction; all that are invited are at liberty to partake, and the life of the guest is sacred; to be invited to the same table implies equality, and to possess life is to possess the invitation. The table is not spread by any set of men, they only pluck the fruit; the Master himself presides, and all he invites are equally welcome. Nor is it the prerogative of one guest to dismiss another from the hall of life; the Master calls on whom he will to vacate a seat, and his voice is irresistibly heard by all."

"Has then all the fruit been gathered? When it has, then, perhaps, will be the time to charge our Maker with folly until the uncultivated land has been brought under the plough, and the exigencies of Nature taxed to extreme, it is improper to say the bounty of Providence is not equal to the wants of man."

MEMO 1093 e

o Chap Barnes   15 Aug 72 19

rom R. Clement   Re: The question of liars

Attached are copies of my attempt to prevent Jack Devlin's N.Y.Times piece on our Christmas Counts from flying back in our faces.

The crux of this is that people like Devlin are irresponsible, and should be avoided. For example, Devlin apparently telephoned Jukes and told him that Clement was preparing to attack him in print (cf Jukes letter of complaint to EJS). This is none of Devlin's business. It jeopardizes my opportunity for publication because Jukes might twist my editor's arm.

Devlin said Arbib called our critics liars, not Arbib. Arbib was probably incautious in giving Devlin the names involved, something he got from me. Devlin probably asked whom do you consider liars, and Arbib was trapped into listing people I have never called liars, though they may be. The same trap was sprung on me at last week's Detroit television show with Don Spencer.

Not much you can do about this rough and tumble except to clean up your language a big.

DEFENDANT'S
EXHIBIT
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DDT defended 1094 e THE SUNDAY OREGONIAN, DECEMBER, 28, 1969

'Unbelievability' of charges aired

BY J. GORDON EDWARDS

The author of this hard-hitting defense of DDT, the "miracle insecticide" hailed for a quarter-century but now under attack by environmentalists, is professor of entomology at San Jose State College. He is a leader among a group of scientists opposing all-out bans on DDT and questioning the safety of substitutes. He wrote this article at The Oregonian's request. We believe the case for DDT should be heard in consideration of the need for controlled use of all insecticides and pesticides.

For 25 years DDT has been a great benefactor of mankind, and it seems incredible that anyone could deliberately seek to deprive us of this remarkable ally in our fight against death, disease and starvation. Recently, however, we have been exposed to a barrage of anti-DDT propaganda which is remarkably untruthful and misleading.

Scientists who are thoroughly familiar with the facts could scarcely believe that anyone would take such accusations seriously. After all, we thought, there are some things (like motherhood, patriotism, and DDT) that simply do not need defending . . . . . at least, not until recently. Alas, we now hear many shallow-thinking counterparts of the anti-vaccination, anti-iodized salt, anti-chlorinated water radicals pointing at DDT and shouting "Wolf."

Unfortunately some of their most preposterous claims have been publicized by "sensationalist" news media, and the public came to believe that some of them are "scientific facts." Documented rebuttals by famed scientists with a lifetime of experience in toxicology, nutrition, cancer research, and other pertinent specialties were accorded very little attention (after all, who gets excited about statements that "DDT is proven not to cause cancer?")

Statements by the chief toxicologist for the U.S. Public Health Service and by the chief of toxicology for the Food and Drug Administration were entirely discounted by many news media, but an assistant professor of chemistry (who never had a course in ecology) became recognized as a "leading authority" on toxicology, nutrition, and ecology.

Similarly, the testimony of leading cancer specialists has often been discounted, in favor of unfounded charges by non-medical men that "DDT may cause cancer." actually, cancer has steadily declined ever-since the advent of DDT (except lung cancer, of course), and no cancer has been caused among the hundreds of employes in the huge DDT factory in California during more than 20 years of operation. The other anti-DDT charges appear to rest on equally shaky ground.

Irresponsible persons often state that: "DDT is everywhere, and is not broken down in the environment," yet this is demonstrably false. Numerous scientific investigations have proven that DDT is broken down by environmental heat, cold, bacteria, alkaline soil or water, soil micro-organisms, aquatic plants, and chemicals within insects and vertebrate animals. It seldom persists more than a few days or weeks, under natural environmental conditions.

Many official agencies regularly analyze our soil, air and water, and the majority of samples contain "no trace" of DDT, even in the Columbia River and in the Mississippi and its tributaries (draining some of the most heavily-sprayed fileds in the world).

Methods of detecting DDT and other insecticides were very crude until recently, but gas chromatography now provides a very sensitive means of detecting their presence. Unfortunately, different chemicals sometimes give identical readings, which last resulted in some gross errors.

Apparently about half of the material identified as DDT in many recent analyses actually is not DDT, but may be PCB (polychlorobiphenyl compounds), which are not of insecticidal origin but are very widespread in the environment.

DDT experiments with mice and birds are very misleading, for they always involve DDT concentrations thousands of times stronger than those ingested by any humans. (We only take in about 0.0005 p.p.m., or "parts per million," daily.)

On long-term diets with 10.0 p.p.m. of DDT (20,000 times as much as in our diet) mallards reproduced much better than those with no DDT, and pheasants fed 50.0 p.p.m. (100,000 times the concentration in our food) were more successful than the "control" birds. Birds are certainly not being "extincted," as the "scare-mongers" keep insisting . . . in fact, they seem to thrive because there is more food available and because they have fewer insect parasites to transmit diseases such as avian malaria, fowlpox, and Newcastle disease.

The Audubon Society bird census shows that robins, blackbirds, doves, quail, pheasants and ducks are much more abundant now than during the pre-DDT years, as every outdoorsman will confirm. In November, 373 bald eagles were counted in a single morning by park rangers at West Glacier, Montana, and in 1969 ospreys were increasing in uninhabited areas (but decreasing where towns and resorts have ruined their habitats).

As for fish, the Columbia River salmon run in 1969 was the greatest since counts began, and the Coho salmon in the Great Lakes have multiplied beyond all expectations. In Wyoming tests, young trout fed on DDT diets for more than a year grew bigger than the "controls." Corvallis (Oregon) tests recently showed that aflatoxins (molds, not pesticides) in hatchery food were responsible for liver tumors in rainbow trout being reared.

The President recently launched a campaign to "end hunger and malnutrition in the United States." That program is doomed, unless DDT and its allieds remain available for use against destructive agricultural pests. Food prices will soar if DDT is banned, for substitute insecticides must be applied 4 to 15 times more often and each application costs 2 to 5 times as much as a DDT treatment.

In October, 8,000 Washington orchardists petitioned the Department of Agriculture not to ban DDT in that state, and California cotton-growers have found that production costs increased seven-fold when substitutes for DDT were used. In 1969, 13 spray pilots have been killed in California by those deadly substitutes and dozens of farm-workers and children became ill from phospate pesticide poisoning.

Substitutes for DDT also eradicated 83,000 colonies of honey-bees in southern California this year (an effect DDT never had) and thousands of pheasants died there from ingesting Azodrin (a highly-recommended substitue for DDT). Last month the American Beekeeping Federation and the American Honey Producers Association told the USDA that substitutes for DDT are decimating bee colonies in Arizona, California and Washington, and expressed great concern for the agricultural future of those states after the insect pollinators have been killed off.

The condition of Oregon's forests is of great concern to Oregonians, and DDT plays a most important role there. When Douglas-fir Tussock Moths threatened thousands of acres near Burns, Forest Service officials used DDT to control them. An excellent "Surveillance Report" (1963) documented the lack of ill effects on fish, wildlife and cattle. It was stated that: "DDT still remains the only known effective insecticide for control of the Douglas-fir Tussock Moth" (ultimate losses prevented by the spray program were estimated to be more than $16 million). Another excellent report, in 1969, dealth with the highly successful Willapa Hemlock Looper control program, and proved that DDT did not adversely affect non-target organisms in the forests, streams or bays.

Fortunately, many sincere citizens are now becoming concerned enough to listen to the scientific evidence that refutes the charges against DDT. The anti-DDT campaign is faltering because of its own unbelievablility, and the public is becoming more aware of the truth about this marvelous chemical compound.

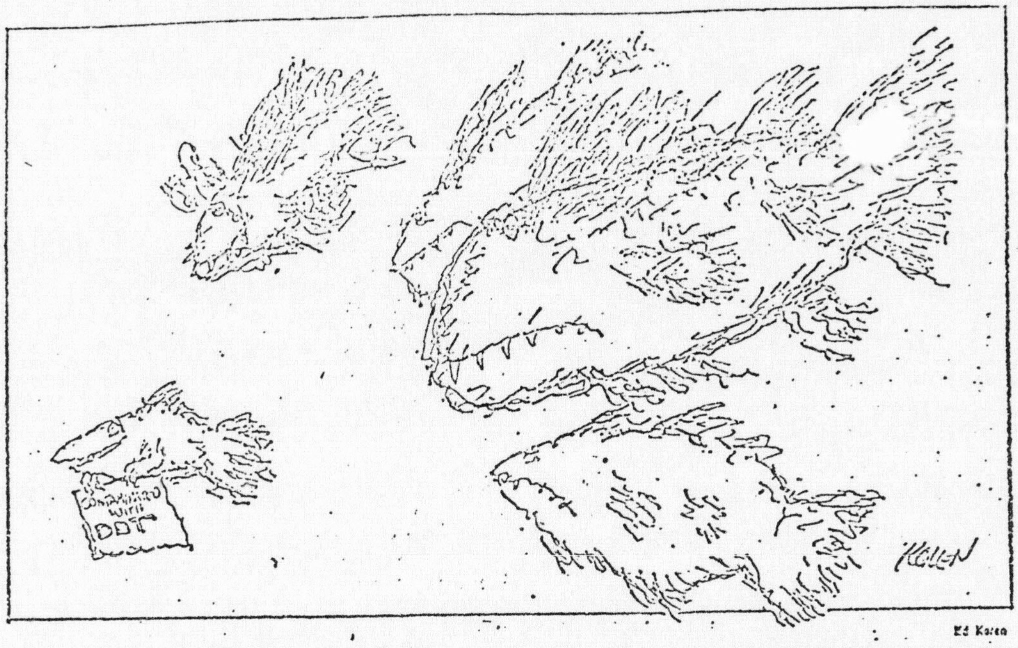
As a result, housewives, tradesmen and business executives will surely join agriculturists, foresters, nutritionists, toxicologists and public health authorities in a belated recognition of DDT for exactly what it is — the safest, most dependable, and most [illegible] ally of mankind in the struggle against environmental waste

Defendant N.Y. Times Exhibit XX

1095 e

8/3/71

Like It or Not, DDT Is Good for You



Ed Koren

By THOMAS H. JUKES

Why is it so necessary to defend DDT and to resist attempts to ban it? First, let it be clear that saving DDT will *not* protect the profits of the chemical industry. Quite the contrary. The replacement insecticides cost far more than DDT, which sells for around 17 cents a pound. DDT is the poor man's chemical—for 25 years the lifesaver of the emerging peoples. So we shall dismiss the rubbish about the robber barons who are allegedly trying to con the public into continuing to buy DDT.

The defense of DDT is vitally important because the ban would be against a most basic human right—the right to be protected against deadly disease. The World Health Organization (W.H.O.) says that without DDT the program against malaria will collapse. This has received very little publicity in this country. On Jan. 22, 1971, the executive board of W.H.O. said, "It is obvious therefore that the withdrawal of DDT would indeed be a major tragedy in the chapter of human health. Vast populations in the malarious areas of the world would be condemned to the frightening ravages of endemic and epidemic malaria."

Malaria is carried by mosquitoes and is the "monarch of diseases." In India, the annual death rate was routinely estimated as one in a hundred malaria cases, but the debilitation and suffering caused by malaria had sociologic effects far more widespread than the deaths. DDT was sprayed on the inside of dwellings to kill mosquitoes and it broke the life cycle of the malaria parasite. In country after country, the spraying program resulted in all the improvements that take place when sick people become well.

Why defend DDT? Because disease and hunger debase mankind, and halt man's upward struggle towards freedom of the spirit. Surely few things are more important than protecting human beings from sickness and starvation.

Why have the opponents of DDT not told the public about malaria, except to state falsely that substitutes for DDT can replace it for controlling this disease? (The W.H.O. emphatically denies this, after testing more than a thousand other insecticides.)

Perhaps this distortion started because the malaria story was omitted from the book "Silent Spring." Also, most of the members of outdoor clubs in this country are prosperous whites. A dramatic crusade for "the environment" attracts many well-to-do followers who have never missed a meal.

The campaign has alleged that DDT can cause cancer in human beings. The American Medical Association says that this is a speculation as yet unproved. The W.H.O. says: "Those who oppose the use of DDT suggest that it may present a hazard as a carcinogen and a mutagen. The experimental evidence in rodents that DDT, even in massive doses, has such effects is inconsistent; in the light of the health record of the people most heavily exposed to it, there is no reason to believe that the millions of people protected against vector-borne diseases are at any risk from their small exposure to DDT."

The stories about DDT and wildlife are controversial. Many of the claims are based on observations that ignored possible poisoning by mercury, lead, or polychlorinated biphenyls. Objections by the wildlife clubs are raised when other people quote bird counts that show increases in population (although, if *decreases* are recorded, DDT often gets blamed). Peregrine falcons are still being counted at Hawk Mountain, Pennsylvania, so they are not extinct. The bald eagle count in Glacier National Park on Nov. 20, 1969, was 373 birds, 120 of which were immature; an all-time high. Roger Tory Peterson said in 1963 that the American robin was probably the commonest bird in North America. A few weeks ago, DDT, in the livers of sea lions found dead, made the headlines. Later it was shown that they died from leptospirosis. So it goes; a new wildlife scare story every month, when what is needed is careful experimental work, without emotional commitment to a fixed concept.

No public relations campaign will save DDT. A public indignation movement might do so. The American tradition is to help people who are suffering. Americans, through their government, have spent half a billion dollars to support the overseas anti-malaria program. As a result, more than 960 million people who were subject to endemic malaria are now free of it; 288 million live in areas where the disease is being attacked.

Banning DDT in the United States would stop the program of the Agency for International Development from purchasing it, and would lead to prejudice against DDT all over the world. The Audubon Society is campaigning to ban its export.

We must not allow millions of people to sink back into disease and misery. We must defeat this campaign.

Thomas H. Jukes is Professor of Medical Physics in Residence at the University of California at Berkeley.

Defendant N.Y. Times Exhibit 22

1096e

The New York Times
August 18, 1971
p. 36, col. 3

DDT: Not Good for Us

To the Editor:

Thomas H. [illegible] [illegible] piece "The [illegible] DDT [illegible] for You" is an [illegible] example of pesticide industry propaganda, an industry of which Professor Jukes [illegible] a part for twenty years.

There are probably some situations in poverty-stricken malarial countries where DDT should continue to be used to hold the line against malaria until less-dangerous means are within the financial reach of those countries. Very few responsible people suggest a ban on export of DDT for these humanitarian uses. Efforts by the Environmental Protection Agency to cancel uses of DDT in the U.S. have no significance for the export of DDT. The situations in malarial countries where DDT is still the pesticide of informed choice are becoming increasingly rare.

But how utterly irrelevant such cases are to non-malarial uses of DDT in the U.S. It is fraudulent to use such arguments to oppose a ban on use of DDT in the U. S. Fortunately, the professor has little impact on pesticide policy except as an industry spokesman. He has published no scientific papers on the subject unless one counts innumerable letters to editors.

Professor Jukes is right though that industry does not have a profit [illegible] for preserving DDT [illegible] declined, not because any [illegible] has taken effect but because [illegible] more insect problems than [illegible]. Profits from DDT use in the [illegible] thus diminishing. The best [illegible] industry's motivation in [illegible] ban is to keep the pressure [illegible] and off other equally destructive [illegible] still profitable pesticides.

[illegible]
Executive [illegible]
Environmental Defense [illegible]
East Setauket, L. I., Aug. [illegible]

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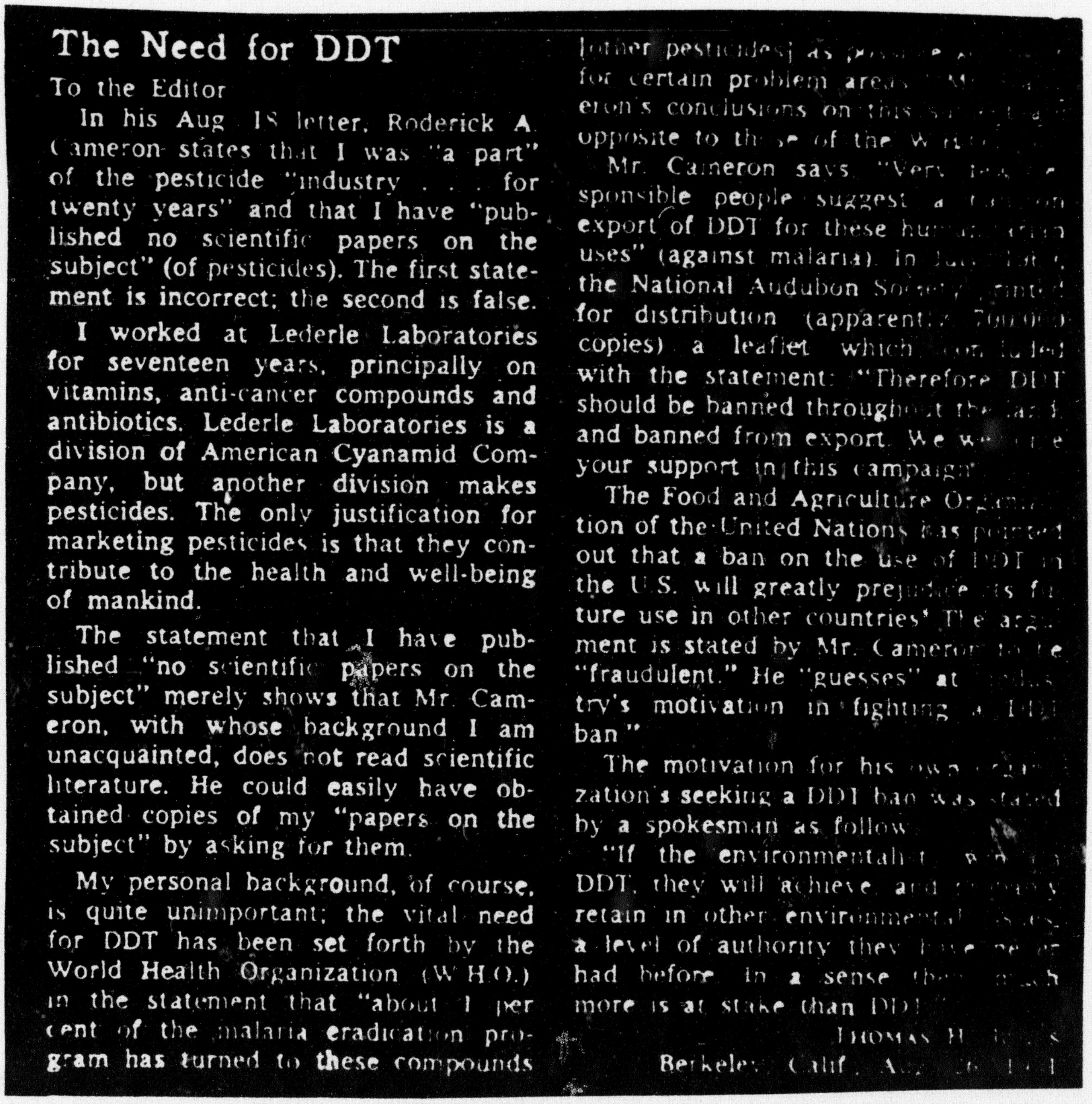
Defendant N.Y. Times Exhibit AAA

1097 e

The New York Times
September 4, 1971
p. 20, col. 3



The Need for DDT

To the Editor:

In his Aug. 18 letter, Roderick A. Cameron states that I was "a part" of the pesticide "industry . . . for twenty years" and that I have "published no scientific papers on the subject" (of pesticides). The first statement is incorrect; the second is false.

I worked at Lederle Laboratories for seventeen years, principally on vitamins, anti-cancer compounds and antibiotics. Lederle Laboratories is a division of American Cyanamid Company, but another division makes pesticides. The only justification for marketing pesticides is that they contribute to the health and well-being of mankind.

The statement that I have published "no scientific papers on the subject" merely shows that Mr. Cameron, with whose background I am unacquainted, does not read scientific literature. He could easily have obtained copies of my "papers on the subject" by asking for them.

My personal background, of course, is quite unimportant; the vital need for DDT has been set forth by the World Health Organization (W.H.O.) in the statement that "about 1 per cent of the malaria eradication program has turned to these compounds [other pesticides] as possible alternatives for certain problem areas." Mr. Cameron's conclusions on this subject are opposite to those of the W.H.O.

Mr. Cameron says, "Very few responsible people suggest a ban on export of DDT for these humanitarian uses" (against malaria). In June 1969, the National Audubon Society printed for distribution (apparently 700,000 copies) a leaflet which concluded with the statement: "Therefore DDT should be banned throughout the land and banned from export. We welcome your support in this campaign."

The Food and Agriculture Organization of the United Nations has pointed out that a ban on the use of DDT in the U.S. will greatly prejudice its future use in other countries. The argument is stated by Mr. Cameron to be "fraudulent." He "guesses" at industry's motivation in fighting a DDT ban."

The motivation for his own organization's seeking a DDT ban was stated by a spokesman as follows:

"If the environmentalists win on DDT, they will achieve and probably retain in other environmental issues a level of authority they have never had before. In a sense then, much more is at stake than DDT."

THOMAS H. JUKES
Berkeley, Calif., Aug. 26, 1971

1098 e

10/2/72

Antibiotics and Meat

By THOMAS H. JUKES

BERKELEY, Calif.—More than twenty years ago, growth of farm animals was found to be improved when small amounts of the common antibiotics—tetracyclines, penicillin, streptomycin—were added to their food. This discovery was rapidly adopted on farms throughout the world, so the supply of meat for human food increased, and the cost of producing meat was lowered.

Every healthy animal harbors trillions of apparently harmless bacteria in its intestines. Finding that feeding antibiotics improved growth in apparently healthy animals meant that some normal intestinal bacteria had a mildly harmful effect which was removed by antibiotics, even though the surviving bacteria were resistant. For feeding antibiotics to experimental animals changed most of the intestinal bacteria to a pattern of antibiotic resistance, without injury to the animal.

Following this, there was much experimental work on the long-term effects of feeding antibiotics. When successive groups of animals were fed low levels of an antibiotic year after year in the same animal house, a great improvement in growth with the antibiotic was obtained in the first year. The response became less in successive years because the control groups, without antibiotics, grew more rapidly when the tests were repeated. Certain harmful bacteria had apparently disappeared rather than becoming resistant. If antibiotics had led to the spread of resistance among disease-causing bacteria, the results would be opposite—the animals receiving antibiotics would have dropped back to the slower rate of growth that was characteristic of untreated animals before the use of antibiotics.

Antibiotics continue their usefulness for farm animals. This is evident from the numerous experiments summarized in an appendix on "economic value" to the Report of the Food and Drug Administration Task Force on the Use of Antibiotics in Animal Feeds, 1972.

The committee estimates that antibiotics saved $414 million in 1970 for producers of meat in the U.S.A. This would be impossible if resistant disease had become widespread during the last twenty years of antibiotic feeding.

To test the safety of several "animal feed antibiotics," lifetime experiments were carried out with huge amounts in the diet of rats. No injurious effects resulted even when the food contained 1 per cent of chlortetracycline (roughly equivalent to forty regular large-size capsules of the drugstore product daily for a human being). Instead, the treated rats lived longer than controls, and had a much lower incidence of infection, especially pus-associated lung disease. Oxytetracycline and tylosin are similarly harmless. Tylosin was tolerated at 5 per cent of the diet. Table salt is more toxic! No evidence of resistant diseases at any level, high or low, was found in any of these experiments.

The real test of safety is to feed the antibiotics directly to human beings. This was done with premature infants, with life-saving results. In one study there were eight deaths in 48 untreated infants, and one death in a parallel group of 47 infants dosed daily with an antibiotic. Obviously, such studies can no longer be carried out now that the value of antibiotics is known.

Nevertheless, in experiments, principally in test tubes, "transferable resistance" can pass from common intestinal bacteria to some organisms of the "gram-negative" type which cause urinary tract infections, for which tetracyclines are sometimes used. Two questions need answering: First, are human patients the main reservoir of resistant bacteria? Apparently, yes; reports from hospitals show that resistance appears when patients are dosed with antibiotics, and disappears when the treatment is stopped. Second: How readily is resistance transferred from farm animals? Studies to help answer this are nearly complete in two hospitals; one in the farm belt of Iowa and the other in industrial Connecticut.

Many people are worried about eating meat containing traces of antibiotics. This problem has been thoroughly studied; the antibiotics are present in only negligible amounts when the animals are fed by approved methods, these traces have disappeared by the time the raw meat reaches the customer, and the common antibiotics are destroyed in cooking.

Thomas H. Jukes is professor of medical physics in residence at the University of California at Berkeley.

Defendant N.Y. Times Exhibit CCC

On Trial Out West

By Thomas H. Jukes

BERKELEY, Calif. — Opposition to teaching evolution still lives, and powerful efforts are in progress to introduce the divine creation story into officially approved California science textbooks. These efforts were opposed at a hearing Nov. 9 by representatives of major religious faiths, including Christians, Jews and Buddhists.

The "creationists" say that animals and plants were made in their present forms, which have never changed. Some creationists also say evolution is a form of atheistic religion that must not be taught to children. The California Board of Education has appointed a creationist, Vernon Grose, to the textbook commission.

Evolution has steadily advanced since the days of Darwin until now it pervades biology. If we compare Darwin's original outline to a DC-3 plane, modern evolution is like a Boeing 707—the DC-3 is still a great plane, but the modern jet goes higher and has wider horizons. Darwin's principles have been strengthened and expanded by the discoveries made in modern genetics, molecular biology and biochemistry. The basic principle remains: the species that is best adapted to its environment wins over its competitors, and certain new mutations give their possessors an adaptive advantage.

In 1953, the structure of DNA was discovered. This forced an entirely new approach to evolution, because DNA carries all the hereditary information and instructions from one generation to the next. Evolution is the study of inherited changes. These can take place only by changes in DNA and these changes often alter the proteins. Scientists are using computers to measure the evolution of DNA and proteins. The procedure is like studying languages.

Let us take the English word "melancholy." It obviously resembles the French word "mélancolique." Even an ardent creationist would admit that the two words must have the same ancestor. This is the Greek word "melancholikos." Protein molecules may be likened to words of great length, written in an alphabet of twenty letters: the amino acids. Hemoglobin is a protein "word" containing a string of 287 such letters. The hemoglobins of human beings and gorillas differ in only two of the 287 letters. Cow hemoglobin is about 29 letters different from both gorilla and human hemoglobins; kangaroo hemoglobin has about 47 differences from cow, gorilla and human hemoglobins.

This rule of measuring difference applies to all "families" of proteins that have been examined. We can even examine the family relationship among deadly tropical snakes by comparing the arrangement of amino acids in the proteins of their venoms. And there is a protein, cytochrome, that is similar in animals, green plants and yeasts, showing that all these have a single ancestor. Proteins evolve at different rates. The hemoglobins and snake venoms have evolved more rapidly than cytochrome, and there is a protein called histone which is almost identical in green plants and mammals. Each living organism is a blend of hundreds or thousands of proteins,

This rule of measuring difference applies to all "families" of proteins that have been examined. We can even examine the family relationship among deadly tropical snakes by comparing the arrangement of amino acids in the proteins of their venoms. And there is a protein, cytochrome, that is similar in animals, green plants and yeasts, showing that all these have a single ancestor. Proteins evolve at different rates. The hemoglobins and snake venoms have evolved more rapidly than cytochrome, and there is a protein called histone which is almost identical in green plants and mammals. Each living organism is a blend of hundreds or thousands of proteins,

evolving steadily at various rates. The characteristics of the organism, even its pattern of behavior, result from the properties of its proteins.

The changes in proteins result from an accumulation of mutations that have been built into DNA during at least two billion years of evolution. The changes are still steadily going on. Human DNA contains about three billion units, called "base-pairs," and one base-pair changes each year or so in the DNA of each species, including the entire human race.

The changes in DNA may be actually measured by testing how well the DNA molecules of two different species "match up" with each other. The tests show that the degree of matching is in proportion to the similarity of the two organisms to each other. The results fit in with the classification of species used by biologists. How exciting it would be to study a form of life from another planet to see if it had a type of DNA that differed from all terrestrial forms.

We are related by a common ancestry to all other living passengers on the planet earth. Surely this knowledge is more impressive than a "creation theory" in which man rejects any kinship with his fellow-creatures. Today, most religions have the concept of a Creator who set in motion the natural forces on which life and the universe are based. One of these forces is the law of evolution, the progress of change with time.

Why do the creationists cling to their ideas? Do they have so great a sense of insecurity in a changing world that they seek to gain self-confidence by insisting on a doctrine that rejects change? Professor W. C. Curtis, who prepared a statement at the Scopes trial, said that he was astonished in 1925 to see the reappearance of a controversy which had been won by the evolutionists fifty years earlier. Why is the argument emerging again? Is the California textbook controversy part of a new distrust of science, a longing for the "good old days"? It is too late; evolution has itself evolved into a guiding principle of science.

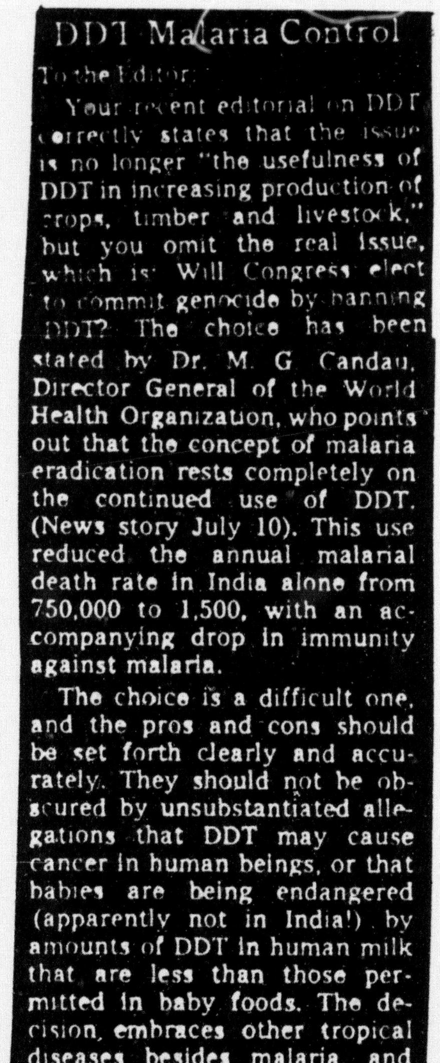
Thomas H. Jukes is professor of medical physics in the Space Sciences Laboratory at the University of California, Berkeley.

Defendant N.Y. Times Exhibit DDD

1/13/73

1100e

New York Times
August 24, 1969
P. 13, Col. 7
(Section 4)



DDT Malaria Control

To the Editor:

Your recent editorial on DDT correctly states that the issue is no longer "the usefulness of DDT in increasing production of crops, timber and livestock," but you omit the real issue, which is: Will Congress elect to commit genocide by banning DDT? The choice has been stated by Dr. M. G. Candau, Director General of the World Health Organization, who points out that the concept of malaria eradication rests completely on the continued use of DDT. (News story July 10). This use reduced the annual malarial death rate in India alone from 750,000 to 1,500, with an accompanying drop in immunity against malaria.

The choice is a difficult one, and the pros and cons should be set forth clearly and accurately. They should not be obscured by unsubstantiated allegations that DDT may cause cancer in human beings, or that babies are being endangered (apparently not in India!) by amounts of DDT in human milk that are less than those permitted in baby foods. The decision embraces other tropical diseases besides malaria, and involves the people of the entire world.

THOMAS H. JUKES
Professor of Medical Physics
University of California
Berkeley, Calif., Aug. 18, 1969

Defendant N.Y. Times Exhibit EEE

The New York Times
August 31, 1969
p. 11, col. 7

For Ban on DDT

To the Editor:

Thomas H. Jukes, one of the perennial defenders of DDT [letter Aug. 24], in commenting on your sound editorial, draws another red herring across the trail by claiming that the Congress would "commit genocide" if it banned DDT.

He conveniently forgets that yellow fever, which is, like malaria, a mosquito-borne disease, was eliminated from the jungles of Central America long before the advent of DDT. We know how.

DDT is merely the "cheapest" —but not the most economic if environmental costs are included in the computation—and by no means the only effective insecticide. In fact, its own effectiveness has been degraded because mosquitoes acquire immunity to it even while it is destroying the ability of other animals to reproduce.

Nevertheless, because it is cheap it has lulled many insect controllers into thinking it is their only tool.

If Americans vote to stop poisoning the environment, the rest of the world will still have the option of following suit or poisoning itself, since DDT can be made abroad. We can help enormously, however, by banning DDT at home. This will force its unecological users to resort to more acceptable chemicals, thus increase economic demand, and induce more production, and bring prices down. That would benefit everyone.

This country must face the alternatives soon and squarely, and ban DDT and other persistent chlorinated hydrocarbon pesticides. If necessary, the production of better insect controls should be subsidized (as was DDT originally); and international agreements should be sought to stop DDT and the other discredited and dangerous insecticides from being introduced into the air and water we all must share here on earth.

ELVIS J. STAHR
President
National Audubon Society
New York, Aug. 27, 1969

Defendant N.Y. Times Exhibit FFF

1102e

The New York Times
September 14, 1969
Section 4, p. 13, col. 7

Defendant N.Y. Times Exhibit GGG

The New York Times
October 5, 1969

DDT's Contribution

To the Editor:

In criticizing my Aug. 14 letter Elvis J. Stahr of the National Audubon Society says I am a perennial defender of DDT. I am a newcomer in the field, however, compared with the society, because Stahr also said, in a letter to Time magazine July 25, that its president warned the nation "of DDT's hazards back in 1946."

During 1946 to 1953, DDT saved five million human lives, improved the economy of many countries in the tropics, and prevented 100 million illnesses. Fortunately for mankind, the society's 1946 "red herring" was ignored.

Stahr says that I have "conveniently" forgotten that yellow fever "was eliminated from the jungles of Central America long before the advent of DDT." This is incorrect. In June 1952, 22 countries had eradication programs for yellow fever that included the use of DDT, as reported by the Pan-American Sanitary Bureau. Furthermore, Central America is infested with a black fly that carries the parasite of river blindness and is susceptible to DDT, as reported in The Times on Feb. 7, 1965.

The World Health Organization stated on Aug. 18 that it "has no grounds to dissuade its member states in malarious regions to abandon a chemical which has saved millions of lives and the discontinuation of which would result in thousands of deaths and millions of illnesses . . . borne out by the recent reappearance of more than a million cases of malaria in Ceylon where spraying was discontinued several years ago, and the persistence of thousands of cases in those few parts of India where the eradication program was handicapped by local inadequacies in the supply of DDT."

Stahr recommends that "DDT and other persistent chlorinated hydrocarbon pesticides" be banned in the United States and that international agreements be sought for the same purpose. A National Research Council in May concluded that ". . . in the absence of adequate information on their [persistent pesticides] behavior in nature, prudence dictates that such long-lived chemicals should not be needlessly released . . .; although persistent pesticides have been replaced in some uses and are replaceable in others, they are at present essential in certain situations."

All of us want to reduce contamination of the environment. The dilemma is to reduce it without sacrificing millions of human lives, which would be lost if DDT were banned.

THOMAS H. JUKES
Berkeley, Calif., Sept. 9, 1969

Defendant N.Y. Times Exhibit HHH

1104e

DICHLORODIPHENYL TRICHLOROETHANE (SHOULD DDT BE BANNED OR PRAISED?)

J. Gordon Edwards

oppose the campaign to outlaw DDT in
ited States because: (1) Such actions
necessary; (2) A ban on DDT use would
ocidal; (3) It is irresponsible to ban
defiance of the testimony of most
l, agricultural, entomological, and
health experts; and (4) The propaganda
ted against DDT is lacking in objectiv-
redibility, and scientific ethics and
fulness. I shall discuss these points
tail.

BAN ON THE USE OF DDT IS UNNECESSARY.

egulations already exist, both on the
and the federal level, which are strict
n to protect the public from pesticides,
ding DDT. If those regulations are com-
with the public will have no need to be
ned about the use of any insecticides.
es break down under environmental cond-
in a matter or weeks or months,rather
ersisting for decades as anti-DDT prop-
ists have alleged. I have compiled a
of nearly 150 references documenting the
down of DDT and its metabolites, which
ailable to interested persons (an anno-
copy is attached). DDT, it is obvious,
graded by chemical, thermal, and biolog-
factors in the environment. Its lack of
e persistence is documented by hundreds of tests on soil, water, air, and tissues of live and dead plants and animals. Since 1960 the levels in environmental sites have steadily declined, and the amount in human fat tissues has fallen from about 12 parts per million (p.p.m.) to an average of only 4 or 5 p.p.m. (this includes the metabolites or residues, as well as the actual DDT). Heavily exposed industrial workers bearing several hundred parts per million of DDT have not suffered any adverse effects, but on the contrary have apparently gained protection from cancer and tumors during the past 22 years of heavy DDT exposure. U. S. Public Health Service publications and investigations bear out that contention. Most other vertebrate animals are similarly unharmed by DDT and residues in the environment, and there are numerous indications that they are actually benefitted by the presence of moderate amounts of the chemical in their environment and in their body tissues.

The environmental effects of DDT are minor, despite the spectacular charges directed against this chemical by environmentalists and their organizations (Environmental Defense Fund, Sierra Club, Audubon Society, etc.). The allegations usually emphasize hazards to fish, birds, and "beneficial invertebrates," but they are based primarily on simple correlations between the presence of DDT (or residues) and the occurrence of ill health, reproductive difficulties, or death. They fail to prove the allegations because they ignore dozens of other

. J. Gordon Edwards
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lifornia State University
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Defendant N.Y. Times Exhibit III

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environmental components which are at least as likely to cause the ill effects, and because they omit explanations of healthy animals that contain much higher residues than do the unhealthy ones.

Efforts to "prove" correlations by means of laboratory "experiments" have been repeatedly analyzed and most have been found to be tendentious, to involve multiple variables, to contain incredible errors, or to be lacking in essential background data. They tend to quote other authors and cite other articles as being confirmatory even when they are not, to rely on unpublished beliefs obtained from other anti-DDT activists, to omit all data that fail to conform with their own hypotheses and to report "conclusions" which are unsupported by the data available. The reader's alarm is heightened because he is usually not told how astronomical the dosages are (customarily many thousands of times the amount in human diets) or how much smaller are the amounts likely to be encountered under environmental conditions by birds, mammals, fish, or other forms of life. Frequently the doses were administered by unnatural means, also, including direct injections into the body cavity, into the uterus, or under the skin. Weanling mice at the Bionetics Laboratory were fed huge doses for three weeks via stomach tubes (200,000 times the mg/kg intake of DDT by humans) but still survived. Equally high doses were injected directly into the uterus of baby mice on their 2nd, 3rd, and 4th days of life, by Heinrichs, in a vain attempt to show adverse reproductive effects might be caused by DDT. Customarily, the reports released to the press simply state that the mice "were given DDT," and the public then assumes that "if it happens to a mouse it might happen to US" . . . which of course was exactly the intent of the "experimenter," all the time!

DDT has been blamed for causing massive fish kills. Interested persons should ask the U. S. Government agencies for charts and graphs documenting the actual causes of fish kills in the United States. They will then learn that ALL pesticides combined have been killing less than 3% of the fish killed in the United States (and DDT killed only a small fraction of that percentage). The major killers of fish are industrial wastes and human sewage.

DDT has also been blamed for killing off big game, or for diminishing numbers of other wildlife. To the contrary, the Annual Big Game Census compiled by the U. S. Department of Interior shows a phenomenal increase in big game harvested annually since the use of DDT began (that harvest almost doubled, between 1948 and 1967).

The success of most bird species during the DDT years is evident to everyone who spends much time outdoors. Judging from the widespread increase in abundance of the birds that live in rather close proximity to man, our modern pesticides have actually helped the birds, rather than harming them. The figures from Audubon Christmas Bird Census records are very interesting, for they definitely indicate a trend upward in most kinds of birds between 1941 and 1960 (our use of DDT declined abruptly beginning in 1960). Those census reports showed an increase of 12 times more robins, 21 times more cowbirds, 38 times more blackbirds, 131 times more grackles, and so forth. More recently, news accounts documented great swarms of blackbirds, red-winged blackbirds, grackles, and robins in many parts of the country. In the summer of 1971 the National Audubon Society sought and received permission to poison 30,000 gulls on one island off the Massachusetts coast, even though gulls are "protected" birds in that state. (That same organization has frequently pointed with alarm at "cracked eggshells" and "high DDT levels" in gulls, but we now see that their numbers have certainly not been declining!) We should also notice that during the DDT years wild turkeys increased from their extremely rare status to such numbers that hunters can now harvest more than 130,000 of them yearly, and mourning doves became so abundant that hunters harvested more than 41,000,000 of them in 1965. Raptorial birds have also increased, despite the propaganda efforts to convince us that they were threatened with extinction by DDT and the allegedly resultant thin eggshells (a shameless untruth. The records of the Hawk Mountain Sanctuary in Pennsylvania have revealed a steady increase in migrating hawks of most kinds, culminating in the sighting of more than 29,000 there in 1968. Numbers of ospreys climbed even higher in 1969 and 1970 (they increased from less than 200 in 1945 to more than 600 in 1970, showing a gradual annual increase during that period of time). This increase occurred even while the anti-DDT groups were shouting that ospreys were "headed for extinction"! Bald eagles continued to increase in rural areas and the Audubon Society in 1970 belatedly increased their official estimate of the number of bald eagles in Montana from 130 to 208, after rangers in Glacier National Park had counted 373 of the great birds in half a day along half a mile of McDonald

in 1969. The White-tailed Kite,
that was formerly very rare and
s greatly extended its range and has
ced a tremendous population explosion
ifornia . . . all during the very heavi-
ears of DDT usage there! The anti-DDT
continues to express great concern, even
e flocks of birds darken the skies and
ters experience longer hunting seasons and
er bags every year. Incredibly, much of
public has been convinced that there
lly is a decrease in numbers of birds, AND
t the decrease resulted from DDT and the
n eggshells it caused.

A BAN ON DDT WOULD BE DELIBERATELY GENOCIDAL

The campaign to ban DDT in the United
tes doesn't bother me personally nearly as
h as the further exhortation to ban exports
DT. Such a move would result in at least
million human deaths annually and perhaps
se to 50,000,000 deaths if we also include
e who starve as a result of being deprived
DT to protect their crops. The Audubon
iety has distributed hundreds of thousands
leaflets to students and teachers, and
se leaflets bear the dictum: "DDT should
banned throughout the land, and banned from
ort." That leaves little doubt as to the
nd of the Society concerning those suffer-
millions of non-white humans in the trop-
s who will die without insecticidal protec-
n from vectors of disease. A UPI news re-
ase from San Francisco (25 February 1971)
tes the Executive Director of the Sierra
b as follows: "The Sierra Club wants a ban,
a curb on persistent pesticides, even in
tropical countries where DDT has kept
laria under control." What interpretation
her than genocide can one place on that
ark, by the medical doctor who stated it?
really don't believe many of the Club's
bers would agree with the statement, IF we
re informed about it in the Club Bulletins
. . but we were not.) As a member of the
erra Club I have vigorously protested such
tions in letters to the members of the
erning board, but have not even received
swers to my letters.

Most nations in the world today are
pendent upon DDT for control of the great-
t killers of mankind . . . malaria, yellow
ver, typhus, plague, sleeping sickness,
cephalitis, Chagas' disease, Oroya fever,
d kala azar, and for control of disabling
seases such as river blindness, elephanti-
sis, and leishmaniasis. There can be no
oral or ethical grounds for deliberately withholding medication from those people OR for depriving them of DDT. Such action goes far beyond the senseless penalizing of our own citizens by banning DDT for agricultural or public health purposes. In the United States we can often kill the vectors of insect-borne diseases by utilizing substitutes for DDT. Unfortunately, those are 3 to 25 times as expensive as DDT and have undesirable side effects. The poor inhabitants of many tropical countries cannot possibly afford such substitutes, and neither can their governments or the international humanitarian organizations such as the World Health Organization or the Agency for International Development. (Even though they could get DDT for less than 20 cents a pound and successfully control malaria with it, many countries still have not been able to afford a malaria eradication campaign!)

3. BANNING DDT IN THE U. S. WOULD BE AN EXTREMELY IRRESPONSIBLE ACTION

The following points indicate a few of the difficulties that will result from a ban on the use of DDT in this country. The list could obviously be expanded upon almost indefinitely.

(1) A ban here would frighten or alarm underdeveloped countries so much that they might terminate their public health uses of DDT, allow crops to be ruined by insects, and live with abundant human parasites, rather than risk being "poisoned" by DDT (for they could not be fully aware of the true nature of the propaganda involved in the "ban DDT" movement in the United States).

(2) We may yet be invaded by insect-borne diseases, as more foreign travel occurs and more pathogens are imported by returning travellers.

(3) More diseases of wild birds will occur, because the substitutes cannot adequately control insect vectors in the natural habitat as DDT did. Such diseases include avian malaria, bronchitis, fowl-pox, and many others.

(4) Aflatoxins in the food are known to be detoxified by the enzymes that DDT causes the liver to produce. Without that detoxification, birds and mammals will continue to die of cancer, because aflatoxins are among the most potent carcinogens known to science and are commonly produced by molds that occur in natural food sources.

(5) U. S. Public Health Service scientists who have studied the effects of DDT and its analogs on tumors and cancer say that it may inhibit cancer formation and prevent tumor production or development.

(6) A ban on DDT would contribute to a decrease in production of food and fibre in the United States and would increase the cost of production.

(7) American cotton growers, truck crop farmers and orchardists really need DDT for many specific insect control programs. Banning it would limit their productivity and may cause severe losses to many of them. It may force large numbers of agriculturalists out of business and discourage others from entering agriculture because they fear a future trend in banning farm chemicals.

(8) The "substitutes" for DDT are believed to kill more than 200 people annually, even though DDT and its residues have never killed anyone. The long-term effects of those substitutes are largely unknown.

(9) Banning DDT would result in the destruction of thousands of honeybee colonies, because the "substitutes" are generally much more toxic to bees than DDT. Without bees to pollinate the crops, much poorer yields result.

(10) Forests will suffer more in the absence of DDT, because "substitutes" are more likely to destroy parasites and predators of pests than does DDT. Gypsy Moths will continue to devastate the eastern hardwood forest, unchecked.

(11) Native shrubs and other ground cover will be damaged or destroyed by natural enemies, and that in turn will result in more erosion and in downstream flooding during rainy seasons. (Because of fewer roots to hold the water.)

(12) Fewer protective areas of cover and concealment and fewer good nesting places will be available after DDT is banned, because more land must be placed under cultivation to compensate for the loss of productivity of existing agricultural land.

(13) With fewer trees and other vegetation, substantial reductions in humidity and elevation of temperature occur, and those changes will cause decimation of birds, mammals, and herptiles, as well as native insects.

(14) Adverse effects on U. S. economy will result from a ban on DDT. Losses of crops, lowered yield, food shortage, higher prices for food and supplies, increased malnutrition, curtailment of farm income, loss of employment, declines in local bird populations, decimation of forests and ornamental trees, and so forth will all threaten as a result of the ban on DDT (and subsequent bans on other insecticides would further aggravate the situation).

(15) If DDT is banned, despite its high degree of safety to man and the environment, legislatures throughout the nation will quickly be questioned: "If DDT was too destructive to use, and was banned because of that fact, HOW can we still permit the use of dieldrin, aldrin, chlordane, heptachlor, and all the other insecticides that are many times grea- er in toxicity than DDT and are in many case much more persistent than DDT, AND are know to be more destructive to birds and other forms of wildlife than DDT." We have alrea been told by spokesmen for the opposition that such is their ultimate goal . . . to ba or strictly limit the use of all farm chemicals. DDT is just the start!

4. THE CAMPAIGN AGAINST DDT LACKS OBJECTIVITY, CREDIBILITY, AND TRUTHFULNE

Most scientists grew up, as I did, with truthful, trustworthy friends and colleagues. It is quite a shock, therefore, to discover that some of our modern scientists have deliberately obscured facts, distorted and misstated data, misquoted sources, padded references with statements only by co-conspirators, and entitled their articles in such a way as to conceal the actual significance of their observations. I am sure that most of us are now aware of the demise of objectivity, of careful analysis, of data verification, and of critical scientific review prior to publication . . . the old days of scientific ethi and morality seem remote. We can cite dozen of examples of flagrant perfidy in articles which are being utilized in the attempt to eliminate DDT and other chemicals. If time permits I shall discuss several of the myths that have characterized the anti-DDT campai during the past three years. The topics tha are in greatest need of discussion and clarification include: (1) the alleged "bird declines due to DDT" (eagles, robins, osprey, peregrines, gulls and pelicans); (2) the "thi eggshell" hoax; (3) the "inhibited photosynthesis" fantasy; (4) the myth of "biological magnification up the food chain"; and (5) the unsupported allegations that DDT causes ill health in the form of hepatitis, poliomyelitis, tumors, cancers, sterility, softening of the brain, etc. Scientists are in a good position to determine the validity of these allegations but laymen, elementary and secondary school teachers, bird-watchers, Sierra Club members, Audubon Society members, and other "environmentalists" lack the technical background needed for legitimate evaluation of the allegations. This has been the strongest weapon of the Environmental Defense Fund!

I hope that a great many truly qualified scientists will take the time to carefully read and evaluate the anti-DDT articles and

speeches, and will then transmit their
luations to their own colleagues and to all
-scientists who are concerned about the
troversy. I feel that scientists MUST take
t action, regardless of the outcome of the
persecution in the courts. Even more
portant than the issues of genocide, finan-
l disaster, and environmental destruction
the principle of scientific truthfulness
credibility. If the public loses confi-
ce in science and in scientists, as a
ult of the tactics used by some scientists
untruthfully incriminate DDT, 2,4,5-T,
charin, cyclamates, monosodium glutamate,
d coloring, phosphates, yogurt, drinking
er, fish, farmers, industrialists, and
th control pills, then we will have lost
only the battles but also the war! We
t not allow that to happen to science in
rica!!

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The Agriculturist And The Food Additive Dilemma

Robert White-Stevens
Agricultural Division,
American Cyanamid Company
New York

Agriculturists - research men, professors, teachers, county agents - have the most important responsibility on earth. For in your hands lies the solution to the greatest problem of mankind, the economic production of food and fiber for the exploding millions of this earth. For only by filling the vacuum of hunger in the world can ultimate peace be achieved among nations. America today leads the world in food production, even to the point of an embarrassing surplus, which in reality is no surplus at all - just sound insurance against disaster for the farmer and against excessive food costs for the urbanite. Fifty years ago one farmer fed himself and four others; today he feeds himself and twenty-four others. And this release from the urgency to produce food and fiber is what has allowed our industry, our education, our research and our culture to flourish - in short, our national wealth.

We now feed 180 million people at a higher nutritional level with a vastly greater array of attractive foods all year round at 21¢ per take home dollar on the same acreage which at one time fed 80 million. While four out of five people in this world today still perish from malnutrition either directly or indirectly, here in America starvation has been banished and, paradoxically perhaps, overeating has in its stead become a major health problem.

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America has led the world in agriculture, and this has been essentially due to the guidance, instruction, education and help the county agents of our states have given the farmers of our country. The technical know-how in animal and agronomic production developed by our universities, federal and state experiment stations and our industrial laboratories would have been a sterile achievement indeed if it were not for the extension of the information to the farm, the application of our know-how literally to the grass roots on the land. This has been the business of the county agent and he has done his job quietly, effectively and with dedication.

For this reason we gather today to pay tribute specifically to one county agent of the state of Oregon, but through him generally to all county agents, past, present and future who have served, now serve and are yet to serve the farmers of this great agricultural state. We salute those who have led the way, over the years, since the hard and sinuous days of the pioneer trekking the Oregon trail, to the wondrous forest preserves, orchards, green fields and flourishing stock farms which make Oregon the fabulously productive and beautiful state it is today.

We pause to salute you men and your colleagues, but you have no time to rest upon your laurels for even greater duties lie ahead. America is basically an agrarian nation, our farm peoples and those in the ancillary services contribute over fifty cents of every productive dollar, and we have become independent of all other nations for our basic needs. This is a very real advance upon which we can count in maintaining our world leadership. There may be those who doubt our leadership in other areas, but in the field of agriculture we are unsurpassed, and we, whose concern it is to sustain the productivity of our farms, must see to it that nothing impairs our present lead.

For in only fifteen years we shall have another 60 million mouths to feed in the United States as well as increasing calls from undernourished peoples abroad. We will be feeding an additional population equivalent to the present populace of Indiana, Ohio, Pennsylvania, New Jersey, New York and the whole of New England. At present acreage yields, this will call for another 100 million acres of arable land; by the end of the century we will need an additional 400 million acres of arable land on the same basis to feed the more than 360 million Americans who will sit down to dinner on New Year's Day 2000.

As we simply do not have such land areas of the required quality available, you and I and all of us in technical agriculture have got to get busy right now, or our nation will lose its position among the nations of the earth. We can do this through research, development and application of technical agriculture. Where we have now made two blades of grass and two ears of corn and two pigs to grow where but one grew before, we must be prepared to grow four. We have already shown the doctrines of Thomas Malthus and those of his modern disciples, the Neomalthusians, to be in error, for they failed to include the factor of scientific research and education in their calculations relating food production to population increase. In America we are now increasing our food production more rapidly than our population, which is one of the most rapid in the world today.

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We have done this because we used the scientific method within the framework of freedom of thought and free enterprise. We have made astounding breakthroughs in plant and animal breeding, in soil management, in forest engineering, in pest control, in agricultural machinery, in food processing and distribution, and each factor and step have been linked together in a continuous chain from the secluded preserve of scientific imagination down to the mundane farmer tilling his soil. The research scientist, the technical agriculturist, the industrial chemist, the biologist, the college professor, the county agent and the farmer have, hand in hand, advanced relentlessly over the past half century and subdued, one by one, the most baffling problems and scourges that have beset and plagued mankind since the dawn of history. It has been the work of many people and each has been as important and significant as the other. Great names in agricultural science have come and gone and have been revered among us, but no one of us can assume credit for more than a minute fraction of this great achievement. It has been perhaps the most resounding victory democracy has won.

Now, gentlemen, this is a victory we cannot and must not allow to slip away; yet this is precisely what can happen if certain forces currently abroad in the land are allowed to range unchecked and unchallenged. I refer to recent developments in the pesticide and Food Additive Laws, and particularly to the administrative interpretation of these laws and to the wild and fearful publicity which has been made of these laws and their relationship to the use of agricultural chemicals on the farm.

No one questions the validity and necessity of Federal and State laws designed and administered to protect the health of the consumer of farm products; and every responsible man in agricultural research, extension and industry recognizes the necessity to establish the safety, as well as the efficacy, of every new chemical to be used in or on edible crops and foodstuffs, before such compound is released for general use. The recent amendment which centered the responsiblity for such prior proof of safety upon the manufacturer is just and certainly acceptable to industry. However, attached to the amendment was a clause, known as the Delaney Clause, which, in a few words, if administered literally reduces the whole agricultural chemical industry, and more importantly its function on the farm to a veritable shambles. This circumstance will inexorably reduce the rapid advances of agricultural science to a slow walk, if not stop it completely: it will discourage the chemical industry to search further for new compounds with which to combat the unresolved scourges of the farmer, and it will inevitably leave the grower at the mercy of a thousand pests which will boil back with relish and alacrity once the pressure of control is removed. The impact of this melancholy event will be, of course, not only a rapid decline in the volume and variety of the bright array of foodstuffs to which we have so happily become accustomed, but more significantly a sharp rise in its price - by perhaps a factor of as much as tenfold.

The Delaney Clause states that no chemical may be used in or on a food or feed product if it is "found to induce cancer when ingested by man or animal". On the face of it this sounds reasonable enough, and certainly no responsible scientist, industrialist, food processor or farmer advocates the increase in cancer under any circumstances. The problem arises from the lack of definition in the Delaney Clause. No indication is given as to how a compound is to be identified as a carcinogen - or cancer inducer - and this is a very debatable point even among cancer specialist. No indication is made as to what dosage level and resulting residue tolerance can be arrived at, and as a zero residue is obviously an impossible value to measure, a suspect compound cannot legally be used at all even under a zero residue registration. For, as analytical procedures are refined, what is a zero residue today may be a detectable or even appreciable level tomorrow. Finally, as the Delaney Clause implies and current administrative officers now interpret, the compound must be proven to be non-cancer inducing in humans as well as in animals. This is a manifest impossibility to achieve; one may be able to prove a compound is a carcinogen, but one cannot prove it is not, anymore than one can prove one is not married. By strict interpretation then, the Delaney Clause virtually precludes all new compounds from the agricultural and food market. I say 'new', because for legalistic reasons the so-called 'grandfather' clause allows compounds antedating the passage of the Delaney Clause to remain. Thus, some compounds may be used on one crop or animal because of predate registration, but not extended to another crop or animal because application for registration postdated the Delaney Clause. In other words, by one use it is considered carcinogenous, by the other it is not. In fact, by either use the compound is not cancer inducing so far as our intensive research can show, for it never would have been introduced in the first place if it were.

These loopholes in the wording of the law have led to misunderstanding, indecision, and some decisions which were clearly based upon subjective rather than objective scientific evidence. Recently some well-publicized decisions have been "based not on knowledge, but on a lack of it", and "perhaps worst of all, in a realm once distinguished for careful, objective inquiry, such a policy would substitute prejudice and superstition for scientific truth." For a wave of fear and alarm has arisen among the consumers of our country, a wave deliberately designed to sweep away the trust and honest thinking in the business of agriculture and food production that it has taken our agricultural colleges, experiment stations, industry and you county agents nearly one hundred years to establish. This criticism, unfortunately, is based on half-truths, scraps of irrelevant and unrelated evidence and, to a large extent, on superstition and outright falsehood. Books and articles have been written and displayed under sensational titles and deliberately publicized to excite fear and alarm out of all proportion to any possible or real danger involved. Incredible pressures have been made upon members of Congress and Federal and State administrators to legislate laws and execute them in a manner which can only lead to the ultimate decline of American agriculture.

The mere fact that such mendacity can even partly take root in high places is a sharp reflection upon the obvious failure of science and industry to bring the simple truth to the people. We have perhaps been remiss in assuming that the truth, long established through the endless toil of our agricultural scientists, would take precedence over the councils of despair, and that time would make the false prophets of our day obscure rather than infamous. This has been a great mistake, and perhaps the confusion which confronts us today is a warning to us that in a democracy it is absolutely essential "to let the people know."

This, then, is paramount among our immediate duties, you and I and all of us who have been trained in agriculture; we who know what our universities and experiment stations do and how they do it, we who know that within the scope of human knowledge and industry every precaution is taken to combine safety with efficacy in the development of agricultural chemicals, we who know this and are convinced of the role our agricultural science has played in the welfare of America, must speak up, and often, and tell the people the truth. We must let the people know there is a far greater chance that their children will die of starvation at five years of age than of cancer at ninety-five. We must reassure the housewives of America that the food she buys and feeds her family is wholesome, nutritious, clean and safe, for we know this to be so. We can do this at the grass roots level where it will carry the greatest weight.

The necessary revisions in the law and in the administration of the law we can safely leave to those best qualified in knowledge and in positions of leadership in our universities, our legislatures and our industries. We can aid them by assuring the people and securing their confidence.

So I say to you, Mr. Henderson, and to your colleagues, the County Agents of Oregon, this is a job each and everyone of you can do to further the

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agriculture of your great state, and in so doing, that of all states in America. For we have little time to lose: we have guests coming for dinner, three hundred and sixty million of them on New Year's Day in the year 2000.

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FADS AND FALLACIES IN THE NAME OF ECOLOGY

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Introduction

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A few years ago Martin Gardner, the mathematical editor of the Scientific American, published a book entitled "FADS AND FALLACIES IN THE NAME OF SCIENCE" in which he recounted a series of anecdotes, clearly intended to be humorous, dealing with some of the crazy ideas of man, which unconfirmed by experimental evidence or practical field experience, became fads which captured the restless imagination of the people and gathered quite a following, fortunately for but a short period in each case.

Fads and shibboleths concerned with man's life style, his food, his education, his health, his spiritual beliefs and particularly his physical environment, have rapidly risen and usually as swiftly waned since man began and certainly as far back as history records.

Such fantasies usually arise from ignorance and fear of the unknown and establish their credence in prejudice and superstition. In the dawn of man when knowledge was very limited and danger and terror lurked at every moment and place, the only security to be found lay in amulets, charms, magic incantations and rituals and a virtual total reliance and belief in a shaman or witch doctor in whom, it was firmly believed, dwelt all knowledge necessary to cure the sick, to divine the hidden and to control all events to come for the benefit of the true disciple.

As the millenia swept past these fakirs often regarded by their people as holy men, recognized they had a good thing going for themselves and protected their positions in society in any way they could consonant with preservation of their public esteem and dignity. The fortuitous dice of life fell often enough their way to reassure their disciples, and when the dice fell the wrong way they invariably explained it as the work of evil spirits and would expose a scapegoat in retribution.

As intellectual enlightenment followed the ascent of man, he shed these superstitious fears, for awhile rather rapidly during the glories of Greece in the golden age of Pericles, but then he retrogressed for almost 2000 years into the nightmare of the Dark Ages once again to emerge into the Age of Reason in the Renaissance.

It was Galileo and his contemporaries who set the feet of men once again on the road to security through intellectual enlightenment. He it was who first recognized that one experiment correctly executed was worth a million opinions, and that one man who knows the facts can withstand the censure of a million who do not know. Upon this single concept has arisen the vast arena of science, accelerating over the intervening centuries to where it stands today.

Yet as Sir Peter Medawar has pointed out "There is a gathering reaction to science in our time, particularly among the young," who, though happily secure in the munificence with which modern technology has garnished their "brave new world" with food and raiment and pleasure, nevertheless "wring their hands over the few isolated miscarriages of technology, while they take its benefactions for granted" --- "and appear to be appressed with a sense of decay and regression-- by a fear of the deterioration of the world through technological innovation." Artificial chemical fertilizers and pesticides are said to be undermining their health: the soil and sea are being irretrievably poisoned by chemical and radioactive wastes they are told; while synthetic drugs merely substitute one disease for another, and modern man oscillates continually under the influence of stimulants and sedatives."

This sense of despondency, of helpless incompetence, of suspicion and doubt prevails everywhere preponderantly among the young people, and they are once again showing distinct signs of retrogression into the former intellectual void of superstition, fear and irrationality. As Sir Peter states "Once again there is a restless ambivalence about philosophical and scientific thinking as if the insufficiency of fact and reason has given a paradoxical validity to nonsense."

THE NEW WITCH DOCTORS

This ferment immediately provides a fertile ground for the modern shamans to emerge as the saviours and prophets of mankind, even though many of them are actually well educated and trained scientists and therefore must know better; but the current situation provides an ideal opportunity to gather fame and fortune not to be ignored for the sake of mere morality and ethics.

And so we find neo-platonism, various wisdoms of the East, astrology and other sundry doctrines gathering support of the people, as they are immersed in a synthesis of confusion and diffusion of science and religion.

Ecology, pollution, environmentalism, conservation, socio-political ethics, capitalism, religion and of course science (particularly chemistry) have all been cast into the pot of public opinion to evolve as a witches brew predicting doomsday and catastrophe.

As a professor at Old Dominion College put it "Eco-freaks have about as much understanding and knowledge of ecology as do Jesus freaks of theology and both obdurately persist in their ignorance." In fact, the two appear to be getting together at a prominent western university, where seminars are now being held on the topic of "Ecology as a Religion" in which will be developed ritual, liturgy, prayer and credo to firmly wed Ecology and Religion into a new faith discipline to be known presumably as Ecoligion.

Funny as this may seem, it has very serious reflections upon the future of our life style, progress and particularly upon the advance of man through science.

Yet science is perhaps the one significant factor which distinguishes our present civilization from all those of antiquity. It is the only factor that can preserve and advance our civilization, for without it we shall fade ignominiously into obscurity as have all great peoples of history. Yet there are those who would curb the works of science, particularly basic research from which spring all the wealth of science; there are those who contend science has outrun its usefulness and that a moratorium against it is in order; there are those who contest man must abandon the power science has brought him, for he has no right to such hegemony over other forms of life on earth; there are those who demand science in the form of chemistry, engineering and biology must be banished from the farms of America and the western world, and allow the so-called Balance of Nature to hold sway.

It is a sure bet that were it really so to come to pass, and mankind was forced to grub for his food and clothing and shelter as he once did from dawn to dusk, always hungry, tired out and insecure, when the only relief was an early death, those very same people who now clamor against science would be the first to complain and to yearn for the good old days when science provided such abundance and a dolce vita for all.

Just consider were the farmers of this country forced to return to organic farming, without fertilizers, pesticides and machinery and food and fiber inevitably became scarce, who among our people would be the first to go hungry, naked and exposed? It certainly would not be the farmers, they would be among the last to suffer.

Yet new bills limiting the use of science on the farm and in the processing, distribution and handling of foodstuffs are continually dropped into the congressional hopper and into those of various states which if put into law can only result in restriction of the food and fiber supply and ultimately raise its price and deteriorate its quality.

Restrictions on the use of pesticides, feed supplements and medicaments are already becoming reflected in mounting retail food costs and declining qualities. The proposed elimination of DES and antibiotics in animals feeds will increase the meat bill of America by at least $1 billion per year. A real sacrifice demanded of the people based upon exceedingly questionable and equivocal scientific grounds. The virtual elimination of the organo chlorine pesticides, particularly DDT, constitutes administrative obeisance to unscientific, emotional public hysteria fomented by a vociferous, irresponsible minority and based largely on exaggerated, non-factual and fabricated evidence. The nations farmers, foresters, public health officials and consumers will indubitably rue the day that such foolish and unwise decisions have been made on their behalf. The preferred replacements for these useful and essentially safe chemical implements have already commenced to take their toll in public safety and health.

FADS THAT ARE FALLACIES

"Organic Natural Foods"

One persistent, though until recently, rather obscure fad is that foods produced naturally the "organic way" are more nutritious, better tasting and ensure a longer, healthier life. For many years this "belief" has lain somewhat quiescent, kept alive by a few "nuts among the berries" but essentially ignored by the well-fed, satisfied and complacent majority. A few obscure magazines have kept the desultory flame alive and a few suppliers have provided the so-called "organic" foods for the true believers. Within the past few years the demand of "organic naturally-grown" foods has suddenly exploded, and it is estimated perhaps 1% of the national food dollar or about $500 million is currently spent for "organic" foods.

Actually, of course, that with the exception of table salt, all foods are organic in the scientific term, and all foods with a few exceptions are produced "naturally." There is therefore no scientific definition of "organic" foods. To protect their position the advocates of "organic" foods are now attempting to have a standard definition written into Federal law. For as it stands any farmer, any packer, any distributor can place the name "organic" on any foodstuff regardless of how it is produced and not break the law. In fact, it is suspected by many food faddists that this is precisely what is occurring. The essence of such a law would require that all "organic" foods must be produced without the use of chemical fertilizers or pesticides (and some extremists demand without machinery either) and that it be processed and handled without the use of preservatives, emulsifiers, conditioners, colorings or supplemental flavorings or nutrients (e.g., vitamins, unless these also are "natural" and produced "organically." Such a law is fret with pitfalls and exceptions and will be impossible either to obey or to administer, and will develop into a briar patch of deception, swindle and shabby fraud.

For firstly crop yields of produce will plummet for lack of balanced mineral nutrition, and the inevitable ravages of insects, disease, weeds and vermin. Secondly, quality will decline to levels which in many cases will prevent shipment across state lines, due to illegal contamination from pest detritus. Examples of which include insect eggs, larvae & frass; fungal infections some of which produce carcinogenic, teratogenic, or debilitating mycotoxins; bacterial contaminants most of which produce toxins, or in the case of milk, eggs and meats, frank zoonotic disease readily transmissable to man; rodent hair, urine and feces which also frequently contain infective organisms. ...

Thirdly, the price of such foods will be at least double the present cost and could readily reach four fold.

Fourthly, were such an absurdity to be thrust upon the farmer, the nation would rapidly collapse for want of food, fiber and shelter. Hunger, destitution and despair would preside and social-political-economic anarchy prevail.

If all the animal manures and human and industrial organic wastes were to be spread evenly over all the arable lands in America, at inordinate cost, it would provide somewhat less than 15% of the nitrogen, phosphorus and potash now applied, and this is regarded as not more than 30% of that which should be applied merely to maintain present fertility.

From the economic, land management, nutritional, public health and socio-political standpoints "organic" farming would be a total bust, and the claims of its adherents are not only unscientific, they are irresponsible, ignorant and unthinkable.

There is not the slightest bit of valid experimental evidence to show organic foods are superior to those produced by scientific agriculture and there are many valid reasons as to why they are inferior.

Fertilizer Chemicals Poison Babies and Cause Concern

Recently a clamor has arisen that the drinking water of the nation and much of the crop food, carries excess levels of nitrate nitrogen, derived from synthetic fertilizers, which produces methemoglobinemia in infants (blue baby) and combining with digested proteins in the human bile forms nitrosamines which in turn induce cancer. Even though the evidence to support both these claims is virtually absent, nevertheless the claim is vociferously promoted by "scientists," who really know better, and eagerly publicized by the press, radio & TV.

In the first place the incidence of fatal methemoglobinemia in infants is so rare as to be approximately equal to fatalities from small pox vaccination, and but a fraction of those from aspirin tablets and penicillin. Furthermore, those which have occurred were traced to well water contaminated with organic manures from animal waste dumps or septic tanks.

The incidence of intestinal carcinoma induced from fertilizer nitrate is pure speculation totally devoid of any unequivocal experimental evidence.

Finally, the percolation of nitrate nitrogen from fertilized cropped soils is actually less than from unfertilized cropped soils; while the levels of nitrate in our rivers, even those coursing the intensively cultivated areas of the midwest, are no higher today than they were at the turn of the century when virtually all nitrogen fertilizer was derived from animal wastes.

Phosphate Detergents and Eutrophication

Although it has largely subsided since the courageous and logical decision of Surgeon General Steinfeld to restore the use of phosphate detergents, the modern eco-prophets continue to intone against their use, aided and abetted by the manufacturers of proposed alternatives and the ubiquitous media.

The fact is that detergent phosphates contribute only about 15-18% of the total phosphorus entering the environment and this total does not comprise the limiting factor in eutrophication. Actually carbonaceous residues and nitrogen primarily from municipal and industrial effluents are the major cause of eutrophication.

In any case algae are a substantial contributing factor in the demineralizing of effluents and could be so managed as to purify potable waters, produce an animal feed comparable to soybeans, or produce a crude fiber useful for paper board manufacture or newsprint or even produce useful chemicals.

Mercury and Lead in the Environment

It has long been known that both mercury and lead are toxic to vertebrates including humans. Some historians contend that lead was a major factor in the demise of the Roman Empire, because the rich Romans stored their wine in lead flasks, ate off lead-glazed crockery and used lead piping in their houses. This continuous exposure to lead-induced plumbism as it accumulated in the blood-forming centers of the skeleton and elicited early sterility and early death.

In 19th century America, the people were still overexposed to lead from paint, glazed dishes and lead plumbing; but today such exposure has been substantially reduced. Analyses of human hair, where lead along with several other toxic elements-- e.g., arsenic -- tends to accumulate show a highly significant decline in lead, some 70-80%, over the past century.

The one form of exposure over which there may be rightful concern, particularly in congested cities, is lead from auto exhausts. However, the tetra ethyl lead in the gasoline, which is highly volatile and constitutes a hazard to those who continually inhale it, emerges as heavy, non-volatile lead oxide particulates from the exhaust and studies in our laboratory reveal such effluvia settle to the ground rapidly within a few yards of the highway. In center cities, however, such particulates can remain suspended for fairly long periods following issue from auto exhausts and are inhaled by the pedestrians nearby. How serious this really is, we are now trying to determine but regardless of our findings, it is just common sense to reduce this avenue of exposure as much as is feasible.

It must be balanced against the power needs of the people, however, which will be substantially curtailed if no lead at all is to be permitted in gasoline. It now seems probable that a combination of low-leaded gas plus lead absorbers in the exhaust system can meet the tolerances that will be required.

There is, of course, the possibility that some non-metalic anti-knock adjuvant will be discovered which is totally degradable and which could be added to gasoline to replace tetra-ethyl lead.

The use of mercury in industry, medicine, dentistry and agriculture has increased enormously during this century. With the development of atomic absorption analytical equipment assay methods have sharply increased in precision. This has led to determinations of minute levels of mercury in a variety of organisms in the environment. The impetus for such surveys arose as a direct result of several clear-cut cases of mercury poisoning among humans.

The most serious of these was the Minimata Bay incident in Japan, where several dozen people developed mercury toxicity from eating fish caught from the bay, into which it was discovered a chlorine manufacturing plant was dumping mercury wastes in considerable quantity. Later, several children in one family in the South West developed chronic mercury toxicity which was traced to pork that had been illegally fed stolen grain treated with an organic mercurial and intended for planting. A number of other similar cases have been reported in Canada, England and Sweden. In all cases the mercury contamination was derived either from industry, or treated seeds, where massive exposure doses occurred.

Mercury was found at levels of 0.6-1.0 ppm in canned tuna fish and fresh-frozen swordfish, alarms were promptly trumpeted across the press and broadcast media, and for awhile sales of both tuna fish and swordfish were suspended. The FDA set 0.5 ppm of mercury as the tolerance level in foods, and the tuna fish business nearly collapsed. When it was later determined that tuna and swordfish caught nearly a century ago and preserved as museum specimens also carried levels of mercury from 0.5 to as high as 2.0 ppm the flurry of public consternation somewhat subsided. But not before both industry and agriculture were thoroughly castigated for polluting the environment with yet another toxic chemical.

The facts are that apart from the isolated and reprehensible incidents such as Minimata Bay, the great bulk of environmental mercury is produced in nature. It is estimated there are over 300 million tons of mercury in the oceans to which man has contributed less than 100,000 tons from all sources including gold mining the biggest source. Evidently man has been consuming mercury in his fish food for millenia, but as he was not aware of it, it did not harm him. Furthermore, Americans carry around in their teeth over a quarter million pounds of mercury amalgam in fillings, which they ingest steadily with their food. Approximately 150,000 lbs. of pure mercury is installed annually into human mouths in the U.S. alone which does not seem to do them any particular injury.

There is no question mercury is toxic in certain forms, and it can circulate in the environment by microbial conversion to methyl mercury to an extent not hitherto realized. As an element it is completely undestructible and has a half life of virtually infinity. It is also true that a great deal more information on the toxicology of mercury is needed particularly on chronic exposure to vertebrates and in combination with other toxic metals such as lead, cadmium, selenium, etc. There is, however, some evidence that selenium tends to antidote the toxicity of mercury, at least within certain limits. Nevertheless, there is no reason to panic over mercury poisoning on the basis of the very skimpy and equivocal evidence of its environmental hazard to date.

Air Pollution

Air pollution in center cities and such traffic-congested areas as the Bos-Wash, Chi-Pitt, and San-San strips in the east, center and west regions of the country respectively, is a serious economic problem amounting to a cost of upwards of $4 billion per year. Most of the hazard, however, arises from gases which cannot be seen and therefore does not worry the public. Visible smoke on the other hand, most of which consists of solid particles although it falls out quite swiftly, disturbs the people very much.

Some of the eco-prophets claim such will eventually block-out the sun and induce another ice age, others conversely claim industrial and auto effluvia will create a greenhouse effect from excess carbon dioxide and cause infra-red light to be captured, raise the planets' mean temperature, cause the ice caps to melt and flood every coastal city in the world. One can, of course, subscribe to either theory, but the probability is that neither will occur.

When the Islands of Krakatau, off Indonesia, exploded volcanically in 1883, a 6000-foot mountain blew 50 miles (261,000 feet) up into the stratosphere carrying over 300 million tons of ash and pumice, which lingered there for several years before it finally descended to earth. This contamination of the atmosphere was greater than the emissions of all the factories on earth for 100 years, yet it had very little effect on the earth's climate, except for creating brilliant sunsets.

Pesticides

There is probably no area of man-made chemicals which has received more vituperative attention from eco-activists than has that of pesticides.

Although attacks on these useful implements in modern agriculture, food processing and distribution and in public health management have been made since the inception of pesticides, it was just a decade ago with the publication of Rachel Carson's "Silent Spring" that a furor arose to the level of a public hysteria.

There are few fads in modern science which have encouraged more "shamans" to creep out from obscurity to do business once again at the age-old stands than has the public fear of pesticides. Extravagant claims made in Carson's book and eagerly accepted as fact, were promptly proliferated, magnified and propounded to the multitude to warn of impending doom for man and his environment. Evidence to support many of these claims when carefully investigated was found wanting, whereupon a number of "scientists" fell furiously to work to produce "experimental" data to prove de post facto that Miss Carson was, of course, quite correct in her hyperbolic assertions

There then followed an astonishing array of so-called scientific papers, some of which were published in journals, the editors of which really must have known better, that "proved beyond a shadow of a doubt" that pesticides, particularly the organo chlorines and specifically DDT:-

-were accumulating rapidly in the environment all over the planet;
-were being magnified in concentration and intensity through the food chain to levels toxic to virtually all higher forms of animal life, including man.
-were killing-off fish, mammals and birds at rates approaching extinction for some species.
-were inducing cancers in man, teratomas in the newborn and mutants in wildlife.
-were destroying the phytoplankton in the oceans, presaging the death of all ocean life and eventually of terrestial life as well through the breakdown of the oxygen cycle.
-were inducing subtle changes in the reproduction of vertebrates, particularly birds, through disruption of essential egg shell formation.
-were creating such violent dislocations of the natural eco-systems as to result inevitably in total catastrophe.
-were, in short, hastening the inexorable doomsday of mankind and his environment.

As each of these dire predictions emerged, fortified by "scientific evidence," which upon a subsequent more rational analysis was often found to be based upon artifactual techniques, invalid statistical reduction and illogical interpretation, the popular press, radio & TV eagerly fanned the flames of public consternation with abundant and sensational coverage.

Conference after conference has been held over the past decade -- some in an atmosphere of objective inquiry, but many in an aura of witch hunting ritual, to assess the available evidence, sift the facts from fancy and issue virtually excathedra reports designed to assess the real hazards extant in the use of pesticides versus the real benefits attributable to their correct use. Curiously it did not seem to make any difference whether the conferees were authentic, qualified authorities in the fields of chemistry, toxicology, statistics, food technology, entomology, etc. or not. If the issued report favored the original Carson theme it was hailed as a indubitable confirmation of her divine revelations, and its authors acclaimed as "Daniels brought to judgement"; while a conference or committee who failed to hold to the Carson line, who insisted upon reviewing the experimental evidence with objectivity and scientific precision, such were condemned as non-scientists, conspirators with agribusiness, heretics and unbelievers and the general public was ardently persuaded to cast them and their report aside if not entirely out of the public arena.

Legal hearings and court cases were promoted with much publicity and fan-fare, and when the judgement fell to the side of the continued use of pesticides as it invariably did, on Long Island, in Wisconsin, in Washington State, in California and most recently at the seven-month, penetrating, EPA hearings, in Washington, D.C., then these judgements too were discarded and obscured by vast clouds of fulminations and generated public clamor.

Considered, objective and completely unbiased conclusions and points of law were submitted by Examiner Edward Sweeney and found DDT, within approved registered use, to be no hazard to man or his environment, to be no demonstrated cause of cancer, or the demise of wildlife, but, on balance, to be a distinct asset to man in food, fiber and shelter production and in the maintenance of public health. These conclusions, too, were rejected unceremoniously as contrary to the public weal. Such a decision can only be regarded as made in obeisance to political expediency. It reduced the long tenuous hearings, testimonies and cross-examinations and the extensive list of entered documents to a farce.

The case made against DDT and by inference its related pesticides is one that could be as easily fabricated against any compound, any product, any process, any individual or any organization as the principles employed and adhered to so fanatically leave nothing just, nothing secure, nothing sacred. This is Lysenkoism in its ultimate expression.

For the actual evidence reveals beyond dispute that when used properly within the recommendations of the approved and registered label that DDT:-

-is not a carcinogen, a teratogen or a mutagen.
-does not suppress the growth of phytoplankton in the oceans.
-has not reduced the bird life of any species, including raptors and brown pelicans to the verge of extinction.
-does not disperse universally in the environment by solution, by particulates, by evaporation or by organism magnification in concentrations which have any biological significance.

-does not persist in the environment indefinitely, but is actually biodegraded by many organisms both micro & macro, plant and animal and by many physico-chemical factors as well including light, alkalis and many mineral salts. In sea water it has a half life of some 15 days.
-does not impair egg shell formation in birds of any species, and does not affect carbonic anhydrase activity.
-does not interfere with the reproduction of any species of plant or animal except invertebrates, and among them it is surprisingly selective at correct doses removing pests without killing many beneficials.

The really astonishing point in this whole fad is that DDT is to be banned because it constitutes a hazard to man's health, yet its use is to be permitted in the event of a serious threat to man's health, for example in the event of a serious epidemic of typhus, malaria, encephalo myelitis, etc. Who is to maintain a substantial inventory in the face of zero sales if not of course considered.

Finally, the denouement of this extraordinary decision is to recommend a substitute for DDT, parathion, which is known to be hazardous and exceedingly dangerous both to man, livestock and wildlife, to persist in both fresh and marine waters as long or longer than does DDT, that is as toxic dermally and via inhalation as it is orally, that has a considerably less effective insecticidal spectrum and yet destroys beneficials at recommended dose levels as effectively as it does target pests. There have already been a large number of recorded deaths from parathion in contrast to DDT for which there is not one single medically annotated human death regardless of dose and despite of the fact that at least one billion humans have been exposed to it for over 20 years.

It is clearly predictable that there will be, sooner or later, a tragic accident with parathion which will entail a large group of human fatalities. Who among the vituperative and tenacious opponents of DDT will answer for such a catastrophe. It is a sure bet like the shamans of old they will all look away or seek a scapegoat to protect their position.

At the present time it is hard to predict which way events with respect to pesticides will turn. Industry for one is heartily discouraged and is understandably steadily withdrawing from further investment in research and development of new pesticidal compounds. Research into biological controls though hopeful and promising in a few isolated cases, is many years from meeting the challenge of total control of even the major pests of the 10,000 which plague man's crops, his livestock, his domiciles and his person. In the meanwhile there are now 208 million people to feed, clothe and shelter in this country alone, and many tens of millions beyond our shores who continue to turn to us for succor. Already the price of food is mounting and as the

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pesticide armamentarium is reduced and their use constrained by increasing restrictions and costs, food and fiber prices will continue to rise.

Perhaps a series of massive epizootics of insects and epidemics of disease among our crops, forests and homes will so incense the public to cause the administrators to reconsider the constraints and restraints they have laid upon the American farmer and let him once again return to his fields and orchards armed with the equipment and chemicals with which agricultural science has provided him. But this will be a grievous price to pay and the impact upon man and his environment will far exceed that fallaciously claimed to be due to the correct use of pesticides by the eco-faddists.

HARD TOMATOES - HARD TIMES

Another shibboleth and false presentation appeared early this year as an official report of the Agribusiness Accountability Project, whatever that is, authored by a Jim Hightower, whoever he is, under the title "HARD TOMATOES - HARD TIMES." The declared objective of this particular tirade was to reveal for public scrutiny "The Failure of the Land Grant College Complex" and it sets out to deprecate and denigrate the century-old system in any way possible and impossible. It deliberately ignores and carefully avoids the vast beneficial contributions made by the system over the past 100 years to the life style and welfare of the American people, and avoids the relief and succor it has brought to tens of millions of less fortunate humans abroad, including the Russians.

Apart from the mischievous objective of bringing down "the establishment" or in more understandable words "the American way of life," it is really an appallingly trivial and superficial report, devoid of objective analysis, scholarly consideration, appropriate documentation or even competent English composition. For example, of the 300 references listed, only 124 could be regarded as reliable. Of the remaining 176, 39 are quotes from interviews many over the phone, private correspondence, and equivocal editorial opinions, 19 are explanatory footnotes and no less than 118 are repetitions of previously cited references. This is an astute way to puff-up the facade of erudition in an otherwise feeble report, a technique presumably borrowed from Rachel Carson's "Silent Spring."

Evidently there was neither the time, energy, scholarship or intent to allow for an objective inquiry or extensive study and collation of the vast documented literature of the history and accomplishments of the Land Grant College-Agricultural Experiment Station system (LGC-AES). For nowhere are even the milepost publications quoted that mark the great strides of agricultural science over the past century. One would have thought that at least a passing reference would be made to the long series of magnificent U.S.D.A. yearbooks which reach back for 35 years, wherein virtually every area and discipline in agricultural research and development is clearly delineated, copiously documented and written in layman's parlance by recognized experts. Even the 1962 Yearbook "After 100 Years" which traces the system since its inception, is omitted. As this series covers virtually all and a great deal more than "Hard Tomatoes - Hard Times," and covers it better and more factually, it is, perhaps, understandable that it would be totally ignored, for it does not comprise "the science print to fit" the preconceived notions of the "Task Force."

The book clearly accuses the LGC-AES system for frittering away the taxpayers money on unnecessary research, trivial publications and top heavy administrative overhead, completely ignoring the fact that the system has over the century, released 95% of the people from the toil of the soil and is currently feeding over twice the population, from half the arable lands for half the food cost of but 50 years ago. It pays back the taxpayer every year more than the total investment in research for a century, a return on investment of 100%. No other industry can make that claim.

"Hard Tomatoes - Hard Times" decries the decline of the small family-owned farm and contends the LGC-AES system is directly responsible for the ruin of rural America and center city congestion and degradation, unemployment, welfare and crime. It maintains that over 210 million people in the U.S. can be adequately fed, clothed and sheltered at a cost commensurate with current economy, from the production of family-owned farms, mostly of less than 100 acres. This utterly ridiculous concept is belied by the fact that over 90% of current agricultural production comes from less than 10% of the farms, and that to reverse this trend would completely disorganize the entire economy and socio-political life style of the nation. It would be as logical to insist that the auto-manufacturing of the nation return to local smithies and machine shops in every town, village and hamlet in the land. The Chinese attempted to do this a decade ago with steel production and it was predictably an economic disaster and a dismal flop.

Nostalgic as it may seem to return to the polyculture family owned and operated farm, it simply could not meet the bare necessaries of the burgeoning urban and suburban population, and hunger, want, destitution and misery would stalk the land if it were to be attempted.

The facts are that the LGC-AES system through its rural extension service, the National Grange, 4-H, Vo-Ag, Future Farmers of America and many other programs, has done an admirable job of slowing the inexorable decline of the family farm and has thereby substantially ameliorated the social impact of the scientific agricultural revolution.

Agribusiness

"Hard Tomatoes - Hard Times" zeros in on what it calls "agribusiness" for its most concerted and vicious attacks.

It carefully defines "agribusiness" as all those commercial concerns which provide the farmer with "inputs" such as seed, fertilizers, pesticides, machinery, credit, insurance, etc., and "outputs" which embrace food processing, distribution, handling and retailing farm products. It pointedly excludes the farmer himself (except corporate owned farms) as agribusiness, which, of course, is absurdly illogical because every successful farmer is the principal agribusinessman. Yet it includes all those industries "which are indirectly involved in farming." As this would include steel and other metals, building, chemicals, transport, communications, textile, utilities, advertising, even education and research, it, in fact, embraces virtually the entire scope of American industry.

This definition of agribusiness clearly delineates what the real target of "Hard Tomatoes - Hard Times" actually is. It is the establishment as a whole, the free enterprise, capitalistic system which is the basis of the American way of life.

But if one merely confines agribusiness to only those industries which provide direct "inputs" and/or "outputs" to the farmer, from where and from whom can the farmer procure such commodities, except from industry. Certainly he cannot provide them himself, the government cannot provide them and if they did so they in turn would have to get them from industry or import them from abroad.

"Hard Tomatoes - Hard Times," completely ignoring this elemental economic fact, proceeds to attack both "agribusiness" and the LGC-AES system for what they claim is a colossal insidious conspiracy between the two to bilk the farmer of his resources, his property and his livelihood and to coincidently overcharge the urban and sub-urban consumer for impure, unnutritious, tasteless and perhaps poisonous food and shabby clothing. Apart from the fact that to have done so would not only have put agribusiness out of business but would have been equally injurious to all those consumers who are also in agribusiness. The facts are that the LGC-AES system provides the most effective research, testing, monitoring and educational service, not only to farmers but to consumers also.

The "Task Force" contends that because agribusiness and the LGC-AES system collaborate closely both in the research and development of such farm "inputs" and "outputs," and also in the education and training of young people to enter agribusiness, that such contacts constitute coercion, malfeasance and corruption. This absurd and totally mischievous accusation ignores the fact that not only is it practically impossible for industry to conduct all their own research and development to meet Federal and State registration and license, but when they attempt to do so they are accused of issuing unreliable, biased and inaccurate data to facilitate early marketing and produce substantial profits. Private research labs are similarly condemned for being "in the pay of industry." The fact is that the only place to which industry can turn to secure the field evaluation of their products, necessary for registration is the LGC-AES system. Obviously a close collaboration between industry and the system becomes an integral part of the testing and review process. To claim such a relationship is dishonest, nefarious and corrupt is not only an evil syllogism but it elicits distrust and lack of confidence among the vast non-farming populace in their essential food and fiber supply.

Such analyses of industry, the educational-research system and the body politic tear down the current operative structure without providing any equally effective or better substitute to replace them. This procedure, if allowed to take root and flourish can only lead to anarchy, and when it is directed at disruption of the food and fiber supply of the nation can only bring socio-political-economic chaos in its wake.

Yet today, essentially based upon this diatribe of towering misinformation a suit has already been filed in Washington to enjoin the Federal Government to cease and desist from providing any further funds in support of the LGC-AES system. Ridiculous as it may appear and certain of defeat as it may be, unquestionably serious injury to the system will be effected unless a major effort is made to rebut and to deflect these absurd accusations. To ignore them and hope they will just blow away in the mists of morning is to be exeedingly naive.

Such an indifferent attitude by LGC-AES and by agribusiness will be interpreted to the public as tantamount to a tacit admission of guilt, and will be exploited in the courts to the uttermost.

CONCLUSION

Fads and fallacies in the name of ecology, conservation and environmental protection have become rampart among the general public in recent years. Promoted by authorities of questionable authenticity and intent these fads and fallacies are reaching into the Halls of Congress and various state legislatures and are becoming translated into laws, many of which are so scientifically unsound that they are, in fact, impossible either to obey or to administer. They can lead only to socio-political-economic chaos or to a sharply declining standard of living for all Americans.

The public must be informed of the facts in each case, and the self interests of the vociferous prophets of doomsday be thoroughly exposed.

To effect this I suggest 12 axioms or basic proposals:

1) That legislative decisions on scientific matters must be written based on objective experimental evidence, and not upon unqualified opinions from vociferous self-appointed custodians of the public welfare.

2) That when scientific experimental evidence demonstrates a preconceived eco-activist supposition or assertion to be wrong, it must be given equal exposure to the public.

3) That there is no such thing as a scientific decision by the democratic process -- there is no Truth by Referendum.

4) That it is more important to preserve the human life of this world than that of obscure species, many of which are probably en route to extinction regardless of the works of man.

5) That rationality and science require concern over probabilities, mathematically delineated rather than over every imaginary possibility of events that in all probability will never happen.

6)That all chemicals are both poisonous and innocuous depending upon dose, exposure route, frequency and species, and that there is a biological threshold value for every chemical on every species.

7) That one good scientifically executed experiment is worth a million opinions.

8) That there is not the slightest difference biologically, chemically or physically between two pure samples of a compound whether synthesized by man or extracted from a natural source.

9) That all foods are "organic" and with but a few exceptions "natural";

and to claim "organically grown" foods are more nutritious than and superior to foods produced by scientific farming and thereby to justify charging substantially higher prices is a shabby fraud on a gullible and unsuspecting public.

10) That there is no such thing as a "Balance of Nature" as commonly depicted as a quiet, serene, peaceful and munificent existence for all creatures; that life is a constant struggle for all species in a nature which is "red of tooth and claw," and which provides the arena for the evolution of all species by the "law of the survival of the fittest."

11) That man enters the arena armed with intelligence, a memory, vertical stance and an optic-chiasmatic vision, with which he has exercised his hegemony, for a while at least, over all other living creatures on earth.

12) That the scientific method owes no allegiance to any political party, religious credo, ethical philosophy, ethnic group or material power, that it is simply a procedure of four steps

A) Observation

B) Deduction

C) Experiment

D) Induction or Prediction

That these steps are totally objective, replicable, calculable, and reliable; what is done with the issuing data and evidence may have ethical, political, or even religious intent and motive, but this does not reflect upon the method itself.

When science is subjected to irrelevant issues such as fads and fallacies in the name of ecology it is non-science usually abbreviated to NONSENSE.

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FADS AND FALLACIES IN THE
NAME OF THE ENVIRONMENT

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Introduction

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A few years ago Martin Gardner, the mathematical editor of the Scientific American, published a book entitled "FADS AND FALLACIES IN THE NAME OF SCIENCE" in which he recounted a series of anecdotes, clearly intended to be humorous, dealing with some of the crazy ideas of man, which unconfirmed by experimental evidence or practical field experience, became fads which captured the restless imagination of the people and gathered quite a following, fortunately for but a short period in each case.

Fads and shibboleths concerned with man's life style, his food, his education, his health, his spiritual beliefs and particularly his physical environment, have rapidly risen and usually as swiftly waned since man began and certainly as far back as history records.

Such fantasies usually arise from ignorance and fear of the unknown and establish their credence in prejudice and superstition. In the dawn of man when knowledge was very limited and danger and terror lurked at every moment and place, the only security to be found lay in amulets, charms, magic incantations and rituals and a virtual total reliance and belief in a shaman or witch doctor in whom, it was firmly believed, dwelt all knowledge necessary to cure the sick, to divine the hidden and to control all events to come for the benefit of the true disciple.

As the millenia swept past these fakirs often regarded by their people as holy men, recognized they had a good thing going for themselves and protected their positions in society in any way they could consonant with preservation of their public esteem and dignity. The fortuitous dice of life fell often enough their way to reassure their disciples, and when the dice fell the wrong way they invariably explained it as the work of evil spirits and would expose a scapegoat in retribution.

As intellectual enlightenment followed the ascent of man, he shed these superstitious fears, for awhile rather rapidly during the glories of Greece in the golden age of Pericles, but then he retrogressed for almost 2000 years into the nightmare of the Dark Ages once again to emerge into the Age of Reason in the Renaissance.

It was Galileo and his contemporaries who set the feet of men once again on the road to security through intellectual enlightenment. He it was who first recognized that one experiment correctly executed was worth a million opinions, and that one man who knows the facts can withstand the censure of a million who do not know. Upon this single concept has arisen the vast arena of science, accelerating over the intervening centuries to where it stands today.

Yet as Sir Peter Medawar has pointed out "There is a gathering reaction to science in our time, particularly among the young," who, though happily secure in the munificence with which modern technology has garnished their "brave new world" with food and raiment and pleasure, nevertheless "wring their hands over the few isolated miscarriages of technology, while they take its benefactions for granted"--- "and appear to be oppressed with a sense of decay and regression-- by a fear of the deterioration of the world through technological innovation." Artificial chemical fertilizers and pesticides are said to be undermining their health: the soil and sea are being irretrievably poisoned by chemical and radioactive wastes they are told; while synthetic drugs merely substitute one disease for another, and modern man oscillates continually under the influence of stimulants and sedatives."

This sense of despondency, of helpless incompetence, of suspicion and doubt prevails everywhere preponderantly among the young people, and they are once again showing distinct signs of retrogression into the former intellectual void of superstition, fear and irrationality. As Sir Peter states "Once again there is a restless ambivalence about philosophical and scientific thinking as if the insufficiency of fact and reason has given a paradoxical validity to nonsense."

THE NEW WITCH DOCTORS

This ferment immediately provides a fertile ground for the modern shamans to emerge as the saviours and prophets of mankind, even though many of them are actually well educated and trained scientists and therefore must know better; but the current situation provides an ideal opportunity to gather fame and fortune not to be ignored for the sake of mere morality and ethics.

And so we find neo-platonism, various wisdoms of the East, astrology and other sundry doctrines gathering support of the people, as they are immersed in a synthesis of confusion and diffusion of science and religion.

Ecology, pollution, environmentalism, conservation, socio-political ethics, capitalism, religion and of course science (particularly chemistry) have all been cast into the pot of public opinion to evolve as a witches brew predicting doomsday and catastrophe.

As a professor at Old Dominion College put it "Eco-freaks have about as much understanding and knowledge of ecology as do Jesus freaks of theology and both obdurately persist in their ignorance." In fact, the two appear to be getting together at a prominent western university, where seminars are now being held on the topic of "Ecology as a Religion" in which will be developed ritual, liturgy, prayer and credo to firmly wed Ecology and Religion into a new faith discipline to be known presumably as Ecoligion.

Funny as this may seem, it has very serious reflections upon the future of our life style, progress and particularly upon the advance of man through science.

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Yet science is perhaps the one significant factor which distinguishes our present civilization from all those of antiquity. It is the only factor that can preserve and advance our civilization, for without it we shall fade ignominiously into obscurity as have all great peoples of history. Yet there are those who would curb the works of science, particularly basic research from which spring all the wealth of science; there are those who contend science has outrun its usefulness and that a moratorium against it is in order; there are those who contest man must abandon the power science has brought him, for he has no right to such hegemony over other forms of life on earth; there are those who demand science in the form of chemistry, engineering and biology must be banished from the farms of America and the western world, and allow the so-called Balance of Nature to hold sway.

It is a sure bet that were it really so to come to pass, and mankind was forced to grub for his food and clothing and shelter as he once did from dawn to dusk, always hungry, tired out and insecure, when the only relief was an early death, those very same people who now clamor against science would be the first to complain and to yearn for the good old days when science provided such abundance and a dolce vita for all.

Just consider were the farmers of this country forced to return to organic farming, without fertilizers, pesticides and machinery and food and fiber inevitably became scarce, who among our people would be the first to go hungry, naked and exposed? It certainly would not be the farmers, they would be among the last to suffer.

Yet new bills limiting the use of science on the farm and in the processing, distribution and handling of foodstuffs are continually dropped into the congressional hopper and into those of various states which if put into law can only result in restriction of the food and fiber supply and ultimately raise its price and deteriorate its quality.

Restrictions on the use of pesticides, feed supplements and medicaments are already becoming reflected in mounting retail food costs and declining qualities. The proposed elimination of DES and antibiotics in animals feeds will increase the meat bill of America by at least $1 billion per year. A real sacrifice demanded of the people based upon exceedingly questionable and equivocal scientific grounds. The virtual elimination of the organo chlorine pesticides, particularly DDT, constitutes administrative obeisance to unscientific, emotional public hysteria fomented by a vociferous, irresponsible minority and based largely on exaggerated, non-factual and fabricated evidence. The nations farmers, foresters, public health officials and consumers will indubitably rue the day that such foolish and unwise decisions have been made on their behalf. The preferred replacements for these useful and essentially safe chemical implements have already commenced to take their toll in public safety and health.

FADS THAT ARE FALLACIES

"Organic Natural Foods"

One persistent, though until recently, rather obscure fad is that foods produced naturally the "organic way" are more nutritious, better tasting and ensure a longer, healthier life. For many years this "belief" has lain somewhat quiescent, kept alive by a few "nuts among the berries" but essentially ignored by the well-fed, satisfied and complacent majority. A few obscure magazines have kept the desultory flame alive and a few suppliers have provided the so-called "organic" foods for the true believers. Within the past few years the demand of "organic naturally-grown" foods has suddenly exploded, and it is estimated perhaps 1% of the national food dollar or about $500 million is currently spent for "organic" foods.

Actually, of course, that with the exception of table salt, *all* foods are organic in the scientific term, and all foods with a few exceptions are produced "naturally." There is therefore no scientific definition of "organic" foods. To protect their position the advocates of "organic" foods are now attempting to have a standard definition written into Federal law. For as it stands any farmer, any packer, any distributor can place the name "organic" on any foodstuff regardless of how it is produced and not break the law. In fact, it is suspected by many food faddists that this is precisely what is occurring. The essence of such a law would require that all "organic" foods must be produced *without* the use of chemical fertilizers or pesticides (and some extremists demand without machinery either) and that it be processed and handled *without* the use of preservatives, emulsifiers, conditioners, colorings or supplemental flavorings or nutrients (e.g., vitamins, unless these also are "natural" and produced "organically." Such a law is fret with pitfalls and exceptions and will be impossible either to obey or to administer, and will develop into a briar patch of deception, swindle and shabby fraud.

For firstly crop yields of produce will plummet for lack of balanced mineral nutrition, and the inevitable ravages of insects, disease, weeds and vermin. Secondly, quality will decline to levels which in many cases will prevent shipment across state lines, due to illegal contamination from pest detritus. Examples of which include insect eggs, larvae & frass; fungal infections some of which produce carcinogenic, teratogenic, or debilitating mycotoxins; bacterial contaminants most of which produce toxins, or in the case of milk, eggs and meats, frank zoonotic disease readily transmissable to man; rodent hair, urine and feces which also frequently contain infective organisms.

Thirdly, the price of such foods will be at least double the present cost and could readily reach four fold.

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Fourthly, were such an absurdity to be thrust upon the farmer, the nation would rapidly collapse for want of food, fiber and shelter. Hunger, destitution and despair would preside and social-political-economic anarchy prevail.

If all the animal manures and human and industrial organic wastes were to be spread evenly over all the arable lands in America, at inordinate cost, it would provide somewhat less than 15% of the nitrogen, phosphorus and potash now applied, and this is regarded as not more than 30% of that which should be applied merely to maintain present fertility.

From the economic, land management, nutritional, public health and socio-political standpoints "organic" farming would be a total bust, and the claims of its adherents are not only unscientific, they are irresponsible, ignorant and unthinkable.

There is not the slightest bit of valid experimental evidence to show organic foods are superior to those produced by scientific agriculture and there are many valid reasons as to why they are inferior.

Fertilizer Chemicals Poison Babies and Cause Concern

Recently a clamor has arisen that the drinking water of the nation and much of the crop food, carries excess levels of nitrate nitrogen, derived from synthetic fertilizers, which produces methemoglobinemia in infants (blue baby) and combining with digested proteins in the human bile forms nitrosamines which in turn induce cancer. Even though the evidence to support both these claims is virtually absent, nevertheless the claim is vociferously promoted by "scientists," who really know better, and eagerly publicized by the press, radio & TV.

In the first place the incidence of fatal methemoglobinemia in infants is so rare as to be approximately equal to fatalities from small pox vaccination, and but a fraction of those from aspirin tablets and penicillin. Furthermore, those which have occurred were traced to well water contaminated with organic manures from animal waste dumps or septic tanks.

The incidence of intestinal carcinoma induced from fertilizer nitrate is pure speculation totally devoid of any unequivocal experimental evidence.

Finally, the percolation of nitrate nitrogen from fertilized cropped soils is actually less than from unfertilized cropped soils, while the levels of nitrate in our rivers, even those coursing the intensively cultivated areas of the midwest, are no higher today than they were at the turn of the century when virtually all nitrogen fertilizer was derived from animal wastes.

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Phosphate Detergents and Eutrophication

Although it has largely subsided since the courageous and logical decision of Surgeon General Steinfeld to restore the use of phosphate detergents, the modern eco-prophets continue to intone against their use, aided and abetted by the manufacturers of proposed alternatives and the ubiquitous media.

The fact is that detergent phosphates contribute only about 15-18% of the total phosphorus entering the environment and this total does not comprise the limiting factor in eutrophication. Actually carbonaceous residues and nitrogen primarily from municipal and industrial effluents are the major cause of eutrophication.

In any case algae are a substantial contributing factor in the demineralizing of effluents and could be so managed as to purify potable waters, produce an animal feed comparable to soybeans, or produce a crude fiber useful for paper board manufacture or newsprint or even produce useful chemicals.

Mercury and Lead in the Environment

It has long been known that both mercury and lead are toxic to vertebrates including humans. Some historians contend that lead was a major factor in the demise of the Roman Empire, because the rich Romans stored their wine in lead flasks, ate off lead-glazed crockery and used lead piping in their houses. This continuous exposure to lead-induced plumbism as it accumulated in the blood-forming centers of the skeleton and elicited early sterility and early death.

In 19th century America, the people were still overexposed to lead from paint, glazed dishes and lead plumbing; but today such exposure has been substantially reduced. Analyses of human hair, where lead along with several other toxic elements-- e.g., arsenic -- tends to accumulate show a highly significant decline in lead, some 70-80%, over the past century.

The one form of exposure over which there may be rightful concern, particularly in congested cities, is lead from auto exhausts. However, the tetra ethyl lead in the gasoline, which is highly volatile and constitutes a hazard to those who continually inhale it, emerges as heavy, non-volatile lead oxide particulates from the exhaust and studies in our laboratory reveal such effluvia settle to the ground rapidly within a few yards of the highway. In center cities, however, such particulates can remain suspended for fairly long periods following issue from auto exhausts and are inhaled by the pedestrians nearby. How serious this really is, we are now trying to determine but regardless of our findings, it is just common sense to reduce this avenue of exposure as much as is feasible.

It must be balanced against the power needs of the people, however, which will be substantially curtailed if no lead at all is to be permitted in gasoline. It now seems probable that a combination of low-leaded gas plus lead absorbers in the exhaust system can meet the tolerances that will be required.

There is, of course, the possibility that some non-metalic anti-knock adjuvant will be discovered which is totally degradable and which could be added to gasoline to replace tetra-ethyl lead.

The use of mercury in industry, medicine, dentistry and agriculture has increased enormously during this century. With the development of atomic absorption analytical equipment assay methods have sharply increased in precision. This has led to determinations of minute levels of mercury in a variety of organisms in the environment. The impetus for such surveys arose as a direct result of several clear-cut cases of mercury poisoning among humans.

The most serious of these was the Minimata Bay incident in Japan, where several dozen people developed mercury toxicity from eating fish caught from the bay, into which it was discovered a chlorine manufacturing plant was dumping mercury wastes in considerable quantity. Later, several children in one family in the South West developed chronic mercury toxicity which was traced to pork that had been illegally fed stolen grain treated with an organic mercurial and intended for planting. A number of other similar cases have been reported in Canada, England and Sweden. In all cases the mercury contamination was derived either from industry, or treated seeds, where massive exposure doses occurred.

Mercury was found at levels of 0.6-1.0 ppm in canned tuna fish and fresh-frozen swordfish, alarms were promptly trumpeted across the press and broadcast media, and for awhile sales of both tuna fish and swordfish were suspended. The FDA set 0.5 ppm of mercury as the tolerance level in foods, and the tuna fish business nearly collapsed. When it was later determined that tuna and swordfish caught nearly a century ago and preserved as museum specimens also carried levels of mercury from 0.5 to as high as 2.0 ppm the flurry of public consternation somewhat subsided. But not before both industry and agriculture were thoroughly castigated for polluting the environment with yet another toxic chemical.

The facts are that apart from the isolated and reprehensible incidents such as Minimata Bay, the great bulk of environmental mercury is produced in nature. It is estimated there are over 300 million tons of mercury in the oceans to which man has contributed less than 100,000 tons from all sources including gold mining the biggest source. Evidently man has been consuming mercury in his fish food for millenia, but as he was not aware of it, it did not harm him. Furthermore, Americans carry around in their teeth over a quarter million pounds of mercury amalgam in fillings, which they ingest steadily with their food. Approximately 150,000 lbs. of pure mercury is installed annually into human mouths in the U.S. alone which does not seem to do them any particular injury.

There is no question mercury is toxic in certain forms, and it can circulate in the environment by microbial conversion to methyl mercury to an extent not hitherto realized. As an element it is completely undestructible and has a half life of virtually infinity. It is also true that a great deal more information on the toxicology of mercury is needed particularly on chronic exposure to vertebrates and in combination with other toxic metals such as lead, cadmium, selenium, etc. There is, however, some evidence that selenium tends to antidote the toxicity of mercury, at least within certain limits. Nevertheless, there is no reason to panic over mercury poisoning on the basis of the very skimpy and equivocal evidence of its environmental hazard to date.

Air Pollution

Air pollution in center cities and such traffic-congested areas as the Bos-Wash, Chi-Pitt, and San-San strips in the east, center and west regions of the country respectively, is a serious economic problem amounting to a cost of upwards of $4 billion per year. Most of the hazard, however, arises from gases which cannot be seen and therefore does not worry the public. Visible smoke on the other hand, most of which consists of solid particles although it falls out quite swiftly, disturbs the people very much.

Some of the eco-prophets claim such will eventually block-out the sun and induce another ice age, others conversely claim industrial and auto effluvia will create a greenhouse effect from excess carbon dioxide and cause infra-red light to be captured, raise the planets' mean temperature, cause the ice caps to melt and flood every coastal city in the world. One can, of course, subscribe to either theory, but the probability is that neither will occur.

When the Islands of Krakatau, off Indonesia, exploded volcanically in 1883, a 6000-foot mountain blew 50 miles (261,000 feet) up into the stratosphere carrying over 300 million tons of ash and pumice, which lingered there for several years before it finally descended to earth. This contamination of the atmosphere was greater than the emissions of all the factories on earth for 100 years, yet it had very little effect on the earth's climate, except for creating brilliant sunsets.

Pesticides

There is probably no area of man-made chemicals which has received more vituperative attention from eco-activists than has that of pesticides.

Although attacks on these useful implements in modern agriculture, food processing and distribution and in public health management have been made since the inception of pesticides, it was just a decade ago with the publication of Rachel Carson's "Silent Spring" that a furor arose to the level of a public hysteria.

There are few fads in modern science which have encouraged more "shamans" to creep out from obscurity to do business once again at the age-old stands than has the public fear of pesticides. Extravagant claims made in Carson's book and eagerly accepted as fact, were promptly proliferated, magnified and propounded to the multitude to warn of impending doom for man and his environment. Evidence to support many of these claims when carefully investigated was found wanting, whereupon a number of "scientists" fell furiously to work to produce "experimental" data to prove de post facto that Miss Carson was, of course, quite correct in her hyperbolic assertions.

There then followed an astonishing array of so-called scientific papers, some of which were published in journals, the editors of which really must have known better, that "proved beyond a shadow of a doubt" that pesticides, particularly the organo chlorines and specifically DDT:-

-were accumulating rapidly in the environment all over the planet;
-were being magnified in concentration and intensity through the food chain to levels toxic to virtually all higher forms of animal life, including man.
-were killing-off fish, mammals and birds at rates approaching extinction for some species.
-were inducing cancers in man, teratomas in the newborn and mutants in wildlife.
-were destroying the phytoplankton in the oceans, presaging the death of all ocean life and eventually of terrestial life as well through the breakdown of the oxygen cycle.
-were inducing subtle changes in the reproduction of vertebrates, particularly birds, through disruption of essential egg shell formation.
-were creating such violent dislocations of the natural eco-systems as to result inevitably in total catastrophe.
-were, in short, hastening the inexorable doomsday of mankind and his environment.

As each of these dire predictions emerged, fortified by "scientific evidence," which upon a subsequent more rational analysis was often found to be based upon artifactual techniques, invalid statistical reduction and illogical interpretation, the popular press, radio & TV eagerly fanned the flames of public consternation with abundant and sensational coverage.

Conference after conference has been held over the past decade -- some in an atmosphere of objective inquiry, but many in an aura of witch hunting ritual, to assess the available evidence, sift the facts from fancy and issue virtually excathedra reports designed to assess the real hazards extant in the use of pesticides versus the real benefits attributable to their correct use. Curiously it did not seem to make any difference whether the conferees were authentic, qualified authorities in the fields of chemistry, toxicology, statistics, food technology, entomology, etc. or not. If the issued report favored the original Carson theme it was hailed as a indubitable confirmation of her divine revelations, and its authors acclaimed as "Daniels brought to judgement"; while a conference or committee who failed to hold to the Carson line, who insisted upon reviewing the experimental evidence with objectivity and scientific precision, such were condemned as non-scientists, conspirators with agribusiness, heretics and unbelievers and the general public was ardently persuaded to cast them and their report aside if not entirely out of the public arena.

Legal hearings and court cases were promoted with much publicity and fan-fare, and when the judgement fell to the side of the continued use of pesticides as it invariably did, on Long Island, in Wisconsin, in Washington State, in California and most recently at the seven-month, penetrating, EPA hearings, in Washington, D.C., then these judgements too were discarded and obscured by vast clouds of fulminations and generated public clamor.

Considered, objective and completely unbiased conclusions and points of law were submitted by Examiner Edward Sweeney and found DDT, within approved registered use, to be no hazard to man or his environment, to be no demonstrated cause of cancer, or the demise of wildlife, but, on balance, to be a distinct asset to man in food, fiber and shelter production and in the maintenance of public health. These conclusions, too, were rejected unceremoniously as contrary to the public weal. Such a decision can only be regarded as made in obeisance to political expediency. It reduced the long tenuous hearings, testimonies and cross-examinations and the extensive list of entered documents to a farce.

The case made against DDT and by inference its related pesticides is one that could be as easily fabricated against any compound, any product, any process, any individual or any organization as the principles employed and adhered to so fanatically leave nothing just, nothing secure, nothing sacred. This is Lysenkoism in its ultimate expression.

For the actual evidence reveals beyond dispute that when used properly within the recommendations of the approved and registered label that DDT:-

-is not a carcinogen, a teratogen or a mutagen.
-does not suppress the growth of phytoplankton in the oceans.
-has not reduced the bird life of any species, including raptors and brown pelicans to the verge of extinction.
-does not disperse universally in the environment by solution, by particulates, by evaporation or by organism magnification in concentrations which have any biological significance.

- does not persist in the environment indefinitely, but is actually biodegraded by many organisms both micro & macro, plant and animal and by many physico-chemical factors as well including light, alkalis and many mineral salts. In sea water it has a half life of some 15 days.
- does not impair egg shell formation in birds of any species, and does not affect carbonic anhydrase activity.
- does not interfere with the reproduction of any species of plant or animal except invertebrates, and among them it is surprisingly selective at correct doses removing pests without killing many beneficials.

The really astonishing point in this whole fad is that DDT is to be banned because it constitutes a hazard to man's health, yet its use is to be permitted in the event of a serious threat to man's health, for example in the event of a serious epidemic of typhus, malaria, encephalo myelitis, etc. Who is to maintain a substantial inventory in the face of zero sales if not of course considered.

Finally, the denouement of this extraordinary decision is to recommend a substitute for DDT, parathion, which is known to be hazardous and exceedingly dangerous both to man, livestock and wildlife, to persist in both fresh and marine waters as long or longer than does DDT, that is as toxic dermally and via inhalation as it is orally, that has a considerably less effective insecticidal spectrum and yet destroys beneficials at recommended dose levels as effectively as it does target pests. There have already been a large number of recorded deaths from parathion in contrast to DDT for which there is not one single medically annotated human death regardless of dose and despite of the fact that at least one billion humans have been exposed to it for over 20 years.

It is clearly predictable that there will be, sooner or later, a tragic accident with parathion which will entail a large group of human fatalities. Who among the vituperative and tenacious opponents of DDT will answer for such a catastrophe. It is a sure bet like the shamans of old they will all look away or seek a scapegoat to protect their position.

At the present time it is hard to predict which way events with respect to pesticides will turn. Industry for one is heartily discouraged and is understandably steadily withdrawing from further investment in research and development of new pesticidal compounds. Research into biological controls though hopeful and promising in a few isolated cases, is many years from meeting the challenge of total control of even the major pests of the 10,000 which plague man's crops, his livestock, his domiciles and his person. In the meanwhile there are now 208 million people to feed, clothe and shelter in this country alone, and many tens of millions beyond our shores who continue to turn to us for succor. Already the price of food is mounting and as the pesticide armamentarium is reduced and their use constrained by increasing restrictions and costs, food and fiber prices will continue to rise.

Perhaps a series of massive epizootics of insects and epidemics of disease among our crops, forests and homes will so incense the public to cause the administrators to reconsider the constraints and restraints they have laid upon the American farmer and let him once again return to his fields and orchards armed with the equipment and chemicals with which agricultural science has provided him. But this will be a grievous price to pay and the impact upon man and his environment will far exceed that fallaciously claimed to be due to the correct use of pesticides by the eco-faddists.

HARD TOMATOES - HARD TIMES

Another shibboleth and false presentation appeared early this year as an official report of the Agribusiness Accountability Project, whatever that is, authored by a Jim Hightower, whoever he is, under the title "HARD TOMATOES - HARD TIMES." The declared objective of this particular tirade was to reveal for public scrutiny "The Failure of the Land Grant College Complex" and it sets out to deprecate and denigrate the century-old system in any way possible and impossible. It deliberately ignores and carefully avoids the vast beneficial contributions made by the system over the past 100 years to the life style and welfare of the American people, and avoids the relief and succor it has brought to tens of millions of less fortunate humans abroad, including the Russians.

Apart from the mischievous objective of bringing down "the establishment" or in more understandable words "the American way of life," it is really an appallingly trivial and superficial report, devoid of objective analysis, scholarly consideration, appropriate documentation or even competent English composition. For example, of the 300 references listed, only 124 could be regarded as reliable. Of the remaining 176, 39 are quotes from interviews many over the phone, private correspondence, and equivocal editorial opinions, 19 are explanatory footnotes and no less than 118 are repetitions of previously cited references. This is an astute way to puff-up the facade of erudition in an otherwise feeble report, a technique presumably borrowed from Rachel Carson's "Silent Spring."

Evidently there was neither the time, energy, scholarship or intent to allow for an objective inquiry or extensive study and collation of the vast documented literature of the history and accomplishments of the Land Grant College-Agricultural Experiment Station system (LGC-AES). For nowhere are even the milepost publications quoted that mark the great strides of agricultural science over the past century. One would have thought that at least a passing reference would be made to the long series of magnificent U.S.D.A. yearbooks which reach back for 35 years, wherein virtually every area and discipline in agricultural research and development is clearly delineated, copiously documented and written in layman's parlance by recognized experts. Even the 1962 Yearbook "After 100 Years" which traces the system since its inception, is omitted. As this series covers virtually all and a great deal more than "Hard Tomatoes - Hard Times," and covers it better and more factually, it is, perhaps, understandable that it would be totally ignored, for it does not comprise "the science print to fit" the preconceived notions of the "Task Force."

The book clearly accuses the LGC-AES system for frittering away the taxpayers money on unnecessary research, trivial publications and top heavy administrative overhead, completely ignoring the fact that the system has over the century, released 95% of the people from the toil of the soil and is currently feeding over twice the population, from half the arable lands for half the food cost of but 50 years ago. It pays back the taxpayer every year more than the total investment in research for a century, a return on investment of 100%. No other industry can make that claim.

"Hard Tomatoes - Hard Times" decries the decline of the small family-owned farm and contends the LGC-AES system is directly responsible for the ruin of rural America and center city congestion and degradation, unemployment, welfare and crime. It maintains that over 210 million people in the U.S. can be adequately fed, clothed and sheltered at a cost commensurate with current economy, from the production of family-owned farms, mostly of less than 100 acres. This utterly ridiculous concept is belied by the fact that over 90% of current agricultural production comes from less than 10% of the farms, and that to reverse this trend would completely disorganize the entire economy and socio-political life style of the nation. It would be as logical to insist that the auto-manufacturing of the nation return to local smithies and machine shops in every town, village and hamlet in the land. The Chinese attempted to do this a decade ago with steel production and it was predictably an economic disaster and a dismal flop.

Nostalgic as it may seem to return to the polyculture family owned and operated farm, it simply could not meet the bare necessaries of the burgeoning urban and suburban population, and hunger, want, destitution and misery would stalk the land if it were to be attempted.

The facts are that the LGC-AES system through its rural extension service, the National Grange, 4-H, Vo-Ag, Future Farmers of America and many other programs, has done an admirable job of slowing the inexorable decline of the family farm and has thereby substantially ameliorated the social impact of the scientific agricultural revolution.

Agribusiness

"Hard Tomatoes - Hard Times" zeros in on what it calls "agribusiness" for its most concerted and vicious attacks.

It carefully defines "agribusiness" as all those commercial concerns which provide the farmer with "inputs" such as seed, fertilizers, pesticides, machinery, credit, insurance, etc., and "outputs" which embrace food processing, distribution, handling and retailing farm products. It pointedly excludes the farmer himself (except corporate owned farms) as agribusiness, which, of course, is absurdly illogical because every successful farmer is the principal agribusinessman. Yet it includes all those industries "which are indirectly involved in farming." As this would include steel and other metals, building, chemicals, transport, communications, textile, utilities, advertising, even education and research, it, in fact, embraces virtually the entire scope of American industry.

This definition of agribusiness clearly delineates what the real target of "Hard Tomatoes - Hard Times" actually is. It is the establishment as a whole, the free enterprise, capitalistic system which is the basis or the American way of life.

But if one merely confines agribusiness to only those industries which provide direct "inputs" and/or "outputs" to the farmer, from where and from whom can the farmer procure such commodities, except from industry. Certainly he cannot provide them himself, the government cannot provide them and if they did so they in turn would have to get them from industry or import them from abroad.

"Hard Tomatoes - Hard Times," completely ignoring this elemental economic fact, proceeds to attack both "agribusiness" and the LGC-AES system for what they claim is a colossal insidious conspiracy between the two to bilk the farmer of his resources, his property and his livelihood and to coincidently overcharge the urban and sub-urban consumer for impure, unnutritious, tasteless and perhaps poisonous food and shabby clothing. Apart from the fact that to have done so would not only have put agribusiness out of business but would have been equally injurious to all those consumers who are also in agribusiness. The facts are that the LGC-AES system provides the most effective research, testing, monitoring and educational service, not only to farmers but to consumers also.

The "Task Force" contends that because agribusiness and the LGC-AES system collaborate closely both in the research and development of such farm "inputs" and "outputs," and also in the education and training of young people to enter agribusiness, that such contacts constitute coercion, malfeasance and corruption. This absurd and totally mischievous accusation ignores the fact that not only is it practically impossible for industry to conduct all their own research and development to meet Federal and State registration and license, but when they attempt to do so they are accused of issuing unreliable, biased and inaccurate data to facilitate early marketing and produce substantial profits. Private research labs are similarly condemned for being "in the pay of industry." The fact is that the only place to which industry can turn to secure the field evaluation of their products, necessary for registration is the LGC-AES system. Obviously a close collaboration between industry and the system becomes an integral part of the testing and review process. To claim such a relationship is dishonest, nefarious and corrupt is not only an evil syllogism but it elicits distrust and lack of confidence among the vast non-farming populace in their essential food and fiber supply.

Such analyses of industry, the educational-research system and the body politic tear down the current operative structure without providing any equally effective or better substitute to replace them. This procedure, if allowed to take root and flourish can only lead to anarchy, and when it is directed at disruption of the food and fiber supply of the nation can only bring socio-political-economic chaos in its wake.

Yet today, essentially based upon this diatribe of towering misinformation a suit has already been filed in Washington to enjoin the Federal Government to cease and desist from providing any further funds in support of the LGC-AES system. Ridiculous as it may appear and certain of defeat as it may be, unquestionably serious injury to the system will be effected unless a major effort is made to rebut and to deflect these absurd accusations. To ignore them and hope they will just blow away in the mists of morning is to be exeedingly naive.

Such an indifferent attitude by LGC-AES and by agribusiness will be interpreted to the public as tantamount to a tacit admission of guilt, and will be exploited in the courts to the uttermost.

CONCLUSION

Fads and fallacies in the name of ecology, conservation and environmental protection have become rampart among the general public in recent years. Promoted by authorities of questionable autnenticity and intent these fads and fallacies are reaching into the Halls of Congress and various state legislatures and are becoming translated into laws, many of which are so scientifically unsound that they are, in fact, impossible either to obey or to administer. They can lead only to socio-political-economic chaos or to a sharply declining standard of living for all Americans.

The public must be informed of the facts in each case, and the self interests of the vociferous prophets of doomsday be thoroughly exposed.

To effect this I suggest 12 axioms or basic proposals:

1) That legislative decisions on scientific matters must be written based on objective experimental evidence, and not upon unqualified opinions from vociferous self-appointed custodians of the public welfare.

2) That when scientific experimental evidence demonstrates a preconceived eco-activist supposition or assertion to be wrong, it must be given equal exposure to the public.

3) That there is no such thing as a scientific decision by the democratic process -- there is no Truth by Referendum.

4) That it is more important to preserve the human life of this world than that of obscure species, many of which are probably en route to extinction regardless of the works of man.

5) That rationality and science require concern over probabilities, mathematically delineated rather than over every imaginary possibility of events that in all probability will never happen.

6)That all chemicals are both poisonous and innocuous depending upon dose, exposure route, frequency and species, and that there is a biological threshold value for every chemical on every species.

7) That one good scientifically executed experiment is worth a million opinions.

8) That there is not the slightest difference biologically, chemically or physically between two pure samples of a compound whether synthesized by man or extracted from a natural source.

9) That all foods are "organic" and with but a few exceptions "natural";

and to claim "organically grown" foods are more nutritious than and superior to foods produced by scientific farming and thereby to justify charging substantially higher prices is a shabby fraud on a gullible and unsuspecting public.

10) That there is no such thing as a "Balance of Nature" as commonly depicted as a quiet, serene, peaceful and munificent existence for all creatures; that life is a constant struggle for all species in a nature which is "red of tooth and claw," and which provides the arena for the evolution of all species by the "law of the survival of the fittest."

11) That man enters the arena armed with intelligence, a memory, vertical stance and an optic-chiasmatic vision, with which he has exercised his hegemony, for a while at least, over all other living creatures on earth.

12) That the scientific method owes no allegiance to any political party, religious credo, ethical philosophy, ethnic group or material power, that it is simply a procedure of four steps

A) Observation

B) Deduction

C) Experiment

D) Induction or Prediction

That these steps are totally objective, replicable, calculable, and reliable; what is done with the issuing data and evidence may have ethical, political, or even religious intent and motive, but this does not reflect upon the method itself.

When science is subjected to irrelevant issues such as fads and fallacies in the name of ecology it is non-science usually abbreviated to NONSENSE.

BEST COPY AVAILABLE

Tulare, Calif.
Nov. 1973

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FACTS AND FALLACIES CONCERNING DDT

The environmental effects of DDT have been minor, despite the spectacular charges directed against that chemical by environmentalists and their organizations. The adverse allegations emphasized dangers to fish, birds, algae, and beneficial insects, but they were based only on simple correlations between the presence of DDT (or its residues) and the occurrence of poor health, reproductive difficulties, or death. They failed to prove the allegations because they ignored dozens of other environmental components which are at least as likely to cause the ill effects, and because they omitted explanations of the healthy animals that contained much higher residues than did the unhealthy ones.

I have opposed the campaign to outlaw DDT in the United States because: (1) Such actions are unnecessary (adequate regulations already existed); (2) A ban on the exports of DDT for public health purposes would be genocidal, resulting in millions of human deaths; (3) It ~~is~~ was irresponsible to ban DDT in defiance of the testimony presented at the EPA hearings and in defiance of the recommendations of the National Academy of Science review panel; and (4) The propaganda directed against DDT has been lacking in objectivity, credibility, truthfulness, and scientific validity.

American Birds

The success of most bird species during the DDT years is obvious to anyone who spends much time outdoors. Judging from the widespread increase in abundance of the birds that live near human habitation, our modern pesticides would appear to have actually aided the birds, rather than harming them! The annual Christmas Bird Counts of the Audubon Society indicated an upward trend in most kinds of birds between 1941 and 1960 (i. e., the years of greatest DDT usage). Those censuses showed an increase (per observer) of 12 times more robins, 21 times more cowbirds, 38 times more blackbirds, 131 times more grackles, and so forth. News accounts have documented great swarms of those birds and many others throughout the country. Gulls became so abundant on the east coast that the National Audubon Society sought and obtained permission to poison 30,000 of them on Tern Island, Massachusetts in 1971 (even though they were supposed to be "protected" by Massachusetts law). During the DDT years the robin (which Rachel Carson claimed was doomed to extinction) exploded into the most abundant bird in North America, according to Roger Tory Peterson and others. Blackbirds threatened to wipe out the corn being grown in northern Ohio and many crops near the DDT-sprayed marshes of our southeastern states. Wild turkeys increased from their extremely rare status of pre-DDT years to a condition of such abundance that hunters have been harvesting more than 130,000 of them annually, and mourning doves became so numerous that more than 41,000,000 of them were harvested in 1965 alone. Despite the allegation that raptorial birds were threatened with extinction by DDT, most kinds of them became more and more abundant (except in areas where human encroachment and environmental destruction discouraged them). The records of the Hawk Mountain Sanctuary in Pennsylvania have indicated a steady increase in migrating hawks of most kinds, culminating in more than 29,000 counted there in 1968 (and even more, since then). At Hawk Mountain the number

Defendant N.Y. Times Exhibit PPP

of ospreys recorded climbed from less than 200 in 1945 to more than 600 annually by 1970... even while the anti-DDT groups were shouting that the osprey was doomed to extinction because of DDT. Bald eagles also continued to increase in most rural areas, and the Audubon Society belatedly acknowledged that in 1970 there were 208 resident bald eagles in Montana, rather than the 130 they had assumed lived there previously. The rangers in Glacier National Park, Montana, counted 373 bald eagles along tiny McDonald Creek in just half a day in 1969! In California the White-tailed Kite greatly expanded its range and experienced a tremendous population explosion.... all during the very heaviest years of DDT usage there. The anti-DDT activists continued to express great concern about bird-life, even while flocks of "endangered" species darkened the skies and hunters experienced longer seasons and larger bags year after year. Incredibly, those activists were able to convince the news media and much of the public that bird numbers were seriously decreasing, AND that the decrease was caused by DDT! They succeeded in that phenomenal feat by sheer force, flooding the news media with stories that were utterly untrue, until they had been repeated so often that concerned persons were heard saying "they *must* be true, or everyone wouldn't believe them!" Well, they were *not* true, but it has taken years for scientists to overcome the tremendous momentum generated by the environmentalist propaganda and to get the actual facts publicized. Meanwhile the losses of crops, forests, income, and human health have been extreme, and it appears that the worst may still lie ahead. Our fight has not been won, however the U. S. Congress is now forcing the EPA to re-evaluate it's position on DDT and perhaps there is still time to save our threatened environment from the short-sighted "environmentalists" who have wielded such power during the past two years.

Banning DDT in the U. S. was an Extremely Irresponsible Action

The following points indicate a few of the difficulties resulting from a ban on the use of DDT in this country. The list could obviously be expanded upon almost indefinitely.

(1) A ban here may frighten or alarm underdeveloped countries so much that they might terminate their public health uses of DDT, allow many crops to be ruined by insects, and put up with abundant human parasites rather than risk exposure to DDT.
(2) We may yet be invaded by insect-borne diseases, as more foreign travel occurs and more pathogens are imported by returning travelers.
(3) More diseases of wild birds will occur, because the substitutes for DDT cannot adequately control the insect vectors in the natural habitats, as DDT did. Serious bird diseases include avian malaria, bronchitis, fowl-pox, and many others.
(4) Aflatoxins in the food are known to be detoxified by the enzymes that DDT causes the liver to produce. Without that detoxification, birds and mammals will continue to die of cancer, because aflatoxins are among the most potent carcinogens known to science and are very commonly produced by molds that occur in natural food sources.
(5) U. S. Public Health Service scientists who have studied the effects of DDT and its analogs on tumors and cancer say that it may inhibit

cancer formation and prevent tumor production or development.

(6) A ban on DDT contributes to a decrease in agricultural production in the United States and certainly increases the cost of food and fibre.

(7) American cotton growers, truck crop farmers, and orchardists really need DDT for many specific insect control programs. Banning it limits their productivity and may cause severe losses to many of them. It may force large numbers of agriculturalists out of business and discourage others from entering the field because they fear a future trend of banning additional farm chemicals.

(8) The "substitutes" for DDT are killing more than 200 people annually, in contrast to DDT and its residues, which never killed anyone. The long-term effects of the substitutes on man and the environment are largely unknown.

(9) A ban on DDT results in the destruction of thousands of honey bee colonies, because the "substitutes" are generally much more toxic to bees than DDT. Without bees to pollinate the crops, much poorer yields result.

(10) Forests suffer in the absence of DDT, because "substitutes" are less effective against certain caterpillars, yet destroy more beneficial insects than DDT. Gypsy Moths will continue to devastate the eastern hardwood forests unchecked, and Tussock Moths will destroy our western fir resources.

(11) Native shrubs and ground cover are destroyed by many natural enemies, which in turn results in more erosion and in downstream flooding.

(12) Protective vegetative cover for birds is thinned and fewer adequate nesting places will be available without DDT.

(13) More land must be placed under cultivation to compensate for the loss of productivity of existing agricultural land. (Thirty million more acres have been placed in production than were needed in 1972!)

(14) With less vegetation remaining, substantial reductions in humidity and elevations in temperature will result. Those changes will decimate birds, mammals and herptiles, as well as harmless native insects.

(15) Countless adverse effects on the U. S. economy will result from bans such as that on DDT. Losses of crops and orchards, lower yields, food shortages, higher prices for food and supplies, curtailment of farm income, decimation of forests, loss of employment in forestry, agriculture and related industries, and so forth all result from the ban on DDT. Subsequent bans on other insecticides will further aggravate the situation.

(16) If DDT could be banned, despite its high degree of safety to man and the environment, legislators now have to face questions such as: "Since DDT was too dangerous to use, how can we permit the use of dieldrin, aldrin, chlordane, heptachlor, nicotine, parathion, zectran, Sevin, and all those other insecticides that are so much more toxic than DDT and are in many cases much more persistent in the environment?" (Spokesmen for the opposition have admitted that their ultimate goal is to ban or greatly restrict the use of all farm chemicals, and have boasted that "DDT is just the beginning."

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The Campaign Against DDT Lacked Objectivity, Credibility, and Truthfulness

F Most scientists grew up, as I did, with truthful, trustworthy friends and colleagues. It is quite a shock, therefore, to discover that some of our modern "scientists" have deliberately obscured facts, distorted or misstated data, misquoted sources, padded references with statements made only by co-conspirators, and titled their articles in such a way as to conceal the actual significance of their observations. The old days of scientific ethics and morality seem remote. I am sure that most of us are now aware of the demise of objectivity, of the lack of conscientious analysis and verification of data, and of the absence of any critical review of manuscripts prior to publication . We have seen dozens of examples of flagrant perfidy and duplicity in articles which have been utilized in the campaign to eliminate DDT and other useful chemicals. F

Topics that are in great need of discussion at scientific meetings and clarification in the popular press (as well as science journals) include the following: (1) the alleged "bird declines due to DDT"; (2) the "thin eggshell" hoax; (3) the myth of "biological magnification up food chains"; (4) the "inhibited photosynthesis" fantasy; (5) the unsupported allegations that DDT causes ill health, hepatitis, poliomyelitis, tumors, cancer, sterility, softening of the brain, etc.; and (6) the actual persistence of DDT and its residues under environmental conditions. Scientists are now in a good position to determine the validity of these allegations, but laymen, elementary and secondary school-teachers, bird-watchers, and "environmentalists" lack the background needed for rational evaluation of the allegations. Dedicated scientists must therefore take the initiative.

Even more important than the issues of genocide, financial disaster and environmental destruction (resulting from the DDT ban) is the matter of scientific credibility. If the public continues to lose confidence in scientists and in environmental protection agencies, as a result of the tactics that have been used by certain powerful environmental organizations to incriminate DDT, 2,4,5-T, cyclamates, saccharin, food coloring, monosodium glutamate, hexachlorophene, phosphates, yogurt, power plants, automobiles, big-business, farmers, chemists, lumbermen, and all technologists, then we will ultimately lose the advantages of enlightened civilization. We must not allow that to happen, in America!

J. Gordon Edwards, PhD
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California State University
San Jose, California 95192
20 November 1973

(Remarks prepared for the Tulare Agricultural Chemical Association)

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SAN JOSE STATE COLLEGE

SCHOOL OF NATURAL SCIENCES AND MATHEMATICS
Department of Biological Sciences

20 November 1969

National Audubon Society
1130 Fifth Avenue
New York, N. Y. 10028

Gentlemen:

I have just been given another copy of the leaflet entitled "DDT -the WRONG insecticide", which bears your address and solicits my support in this campaign. Unfortunately nearly every statement on this leaflet is demonstrably wrong, and the dissemination of such erroneous information is criminally irresponsible! It grieves me to see the Audubon Society playing an active role in the degradation of human life and welfare, for the organization had previously seemed sincere, well-informed, and reliable. Members and friends have assumed that statements made in the name of the Society were truthful and had been adequately investigated. After the truth about DDT becomes firmly established (as it certainly will, for it is too important an issue to be quietly dropped during the coming years) the Society will suffer very greatly from the resultant lack of public confidence. The stance of Society leaders on this major issue is extremely unfortunate, not so much because of future damage to the Society itself but because it is contributing appreciably to the deaths of hundreds of millions of humans from starvation and from the insect-borne diseases that still ravage undeveloped human societies. There are more than a dozen such diseases that are controlled or controllable in those societies ONLY by DDT, according to the World Health Organization's 1969 Annual Report. The worst of these is malaria, but typhus, yellow fever, Carrion's disease, elephantiasis, encephalitis, hemorrhagic fever, African sleeping sickness, river blindness, plague, kala azar, and cutaneous leishmaniasis are also cited as being primarily controlled by DDT (in regions where they are under control). In the tropics there are still more than 200,000,000 cases of malaria each year, of which 2,000,000 die each year. The World Health Organization is desperately attempting to expand its control over malaria, using DDT in most of its malarial eradication programs because it is cheap, available, and harmless to man and the environment. Certainly all humane members of the Audubon Society must be appalled by the Society's participation in this blatantly genocidal anti-DDT campaign that will, if successful, doom millions of people in non-affluent countries throughout the world! I cannot believe that those members with any true compassion for suffering humanity will support the Society's stand on DDT after they become aware of the genocidal goals of the anti-DDT zealots. Their propaganda is especially repugnant because they solicit support from well-meaning persons by making wild claims that elicit emotional reactions against DDT while ignoring the testimony of the leading authorities in each scientific area involved. (Those authorities are extolling the truth and refuting those wild claims, but do not have the great financial backing or the biased press coverage of the anti-DDT zealots.)

Original said "India". Attached copy of my letter of 29 Nov. corrected it, to "In the Tropics"

125 SOUTH SEVENTH STREET, SAN JOSE, CALIFORNIA 95114 (408) 294-6414

Defendant N.Y. Times RRK.

The dispersal of truthful scientific information to Society members may be beyond expectation at this late date, after the public relations staff has so strongly committed us all to the heinous objectives of that small number of paid anti-DDT agitators. Concerned members of the Society will be exposed to the truth from many other sources, however, and responsible elements within the organization must then either openly disassociate themselves from the Society or (if they remain silent) bear a burden of guilt far surpassing that borne by Hitler's silent countrymen during the years of Nazi brutality and extermination. Today we see these affluent Americans, thoughtless and complacent, sentencing hundreds of millions of humans to death by urging a ban on DDT throughout the world while not even caring enough to ask the authorities for the facts concerning the effects of DDT on the environment! The anti-DDT alarmists have shouted that DDT is endangering a few kinds of birds, fish, and oysters. We know that those charges are false, but even if they were true just how many starving African, Indian, and South American babies should we sacrifice for each peregrine falcon, and how many suffering victims of malaria, typhus, or river blindness should we exchange for each pelican? How can the Audubon Society encourage Americans to help campaign in favor of these unconscionable acts of genocide?? Which of the following propagandist's lies have influenced you to substitute birds and oysters for human lives and human welfare?

Is it the erroneous belief that DDT in the environment causes thin egg-shells in falcons, ospreys, finches, pheasants, ducks, etc.? An abundance of scientific data has been published by authorities, showing that there is no truth to the claim that DDT in those birds hinders reproduction or causes thin-shelled eggs. Interested persons should read the publications by J. B. DeWitt (1956), D. J. Jefferies (1969), J. H. Enderson (1969), and R. G. Heath (1969). Even at doses of DDT much higher than found in the environment, those scientists found that egg-shells were thicker or that reproduction was more favorable among the DDT-fed birds than among the "control" birds! May we be allowed to provide facts such as are available in those publications for the information of Audubon Society members, to prove how they have been brain-washed by the anti-DDT campaigners? Those facts cannot be suppressed forever, and it would seem preferable to permit Society members to hear them now, so that they may be qualified to make reasonable decisions rather than relying entirely upon emotional judgements in this important matter.

Is it the erroneous belief that DDT in the environment might cause cancer in wildlife or that DDT in our food might cause cancer in man? Professional toxicologists, nutritionists, and cancer specialists refute this in all data published, based on actual experimental investigations during the past 25 years of DDT use. They specifically state that cancer of man has declined steadily since the introduction of DDT into the environment in 1943 (except for lung cancer). They also state that: "there is no evidence that establishes a cause-effect relationship between DDT and cancer". Are Society members to reject those views of authorities and accept instead the theories of botanists, ornithologists, and an assistant professor of chemistry or biology? They have!

Is it the erroneous belief that DDT is decimating bird-life in United States? The Audubon Society's own annual Christmas Bird Census reports prove that this is not true.... why not publish the entire census in Audubon Magazine, covering the past 30 years, so that members can see the evidence for themselves before making a decision concerning the value of DDT in our environment? Similarly

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great increases are found in big game counts, small game counts, and game bird counts. Why is not the membership of the Society informed of those facts, instead of reading only your "big lie" propaganda to the contrary? The anti-DDT crowd also insist that fish are endangered by DDT in the lakes and streams, and even in the ocean. The actual data prove otherwise even in highly polluted areas such as San Francisco Bay with its great burden of untreated sewage. In less-polluted areas fish still abound, and the salmon run up the Columbia River in 1969 has been the greatest ever recorded! Do the frightened members of the Audubon Society ever hear about these facts from the public relations arm of the Society, or are they limited to what is stated on the leaflets published by the Society for some ulterior motive?

Is it the erroneous belief that DDT from spray programs persists in the soil, water, air, and inside living organisms, for many years? It does NOT, as has been proven by an abundance of scientific investigations during the past two years. DDT is degraded into non-toxic residues by heat, by cold, by alkaline soil or water, by ultraviolet light, by water containing green plants or live insect larvae, by soil containing normal micro-organisms, by common widespread bacteria, and by many chemicals that are present in all kinds of living animals. Why does not the Society inform the members that DDT usually breaks down in less than a year, and frequently degrades in less than a month? Would not that be a reasonable attitude for an organization that is seriously interested in having its members behave as responsible citizens?

It is still not too late to publicize the scientific truths concerning the false statements made by the Environmental Defense Fund members and repeated in the recent Audubon Society leaflets. Such a humanistic gesture would help members of the Society to make a rational choice with respect to the suggested ban on DDT. Hopefully you are not dedicated solely to the prevention of rational decisions by members, by heavy-handed propaganda distribution! Society members deserve the opportunity to read the facts, rather than being moulded into misinformed genocidal robots mouthing the errors and distortions that have been programmed into them by a handful of irresponsible exponents of anti-DDT vitriol. Any reputable biologist who has kept abreast of the field can supply the publications providing scientific data on each of the topics mentioned here, but I would urge you to seek information from more specific sources also. Ask several toxicologists for their opinions, to see if they agree with the opinion of Dr. Wayland Hayes (formerly chief toxicologist for the U. S. Public Health Service), Dr. T. A. Loomis (State Toxicologist for Washington State, with 22 years of experience in the field), and Dr. Richard T. Rappolt (Editor of "Clinical Toxicology" magazine). Ask a number of cancer specialists to see if they agree with Dr. Hardin B. Jones (Professor of Medical Physics at University of California, with nearly 30 years of experience in carcinogenic work). Ask a number of nutritionists if they agree on the effects of DDT in the human diet. Ask specialists in agricultural entomology for specific answers to questions concerning possible substitutes for DDT, and their relative inefficiency or undesirable side-effects. Ask the World Health Organization for reliable information about the use of DDT in protecting hundreds of millions of humans from the diseases I have mentioned above. After all that, you will be better equipped to comment on the controversy!

Not only is it criminally irresponsible to campaign for world-wide genocide by encouraging the proliferation of insect-borne diseases; it is equally irresponsible to deliberately sabotage the agricultural industry and thereby condemn hundreds of thousands of humans to starvation. Despite the present high rate of starvation throughout the world and the spectre of infinitely worse conditions ahead, we are now being urged to cut our production of food! Also, during the 2-year absence of DDT in California cotton fields the cost of production of that staple item has jumped from $10.00 or $15.00 per acre to as much as $75.00 per acre, and the future of the cotton producing industry in California is gravely threatened. Substitute insecticides have killed large numbers of birds and small mammals, and have also killed off nearly 83,000 colonies of honey bees in 1968 (without the bees, great numbers of trees and crops cannot be pollinated and will not develop fruit or seed). Here is one area in California that will know dismal agricultural failure as a result of the elimination of DDT in the insect control program... how many times will the tragedy be repeated before a rational solution is allowed? Food is rapidly becoming scarce, even in this country. The government is recommending $3 to $5 billion be made available to help combat starvation and malnutrition in the United States during the next three years. Even with great financial aid, agricultural and nutritional catastrophe can not now be avoided if farm workers are denied the weapons they must have to maintain their pre-eminence as producers of food and fibre. In Biafra last year more than 10,000 persons, mostly children, died of starvation every week, and the numbers that are starving to death daily in India, Africa, and Asia are beyond comprehension. In the face of this desperate world-wide shortage of food, any civilized person who deliberately encourages actions designed to result in massive human starvation should be placed on trial beside the fiends responsible for the World War II concentration camps. (A much smaller total number of people were executed during all of the war years there than our anti-DDT zealots, if successful, will condemn to death each day.) If a small group of persons is successful in their scheme to ban DDT in United States and prohibit its export to needy countries, and if they succeed because of the great power wielded by the membership of this revered Society, then the silent but acquiescent members must eventually face the bar of moral judgement along with that small group of genocidal activists and plead guilty to assisting in the greatest deliberate blood-bath in human history. They will bear that guilt if they withhold DDT from those who need it (without reasonable justification for doing so) for they will be directly responsible for well over 200,000,000 human deaths.... deaths that can be prevented if DDT is permitted to remain available to those desperate, suffering people who live amid the dozens of insect-borne diseases that the World Health Organization can now control only by the appropriate use of DDT.

Which shall it be, Audubon Society, humanitarian concern and constructive action, or a distinct share in the responsibility for millions of future human deaths? How deep does your concern for thin egg-shells and DDT in the fat tissues of birds really go? Does it seem reasonable and responsible to choose to oppose DDT on the basis of such questionable evidence as that presented by the Environmental Defense Fund, when the likely effects on mankind are so devastating? The decision still rests in your hands.

Your recent actions and pronouncements indicate that you have deliberately embarked on a course against DDT, regardless of the lack of convincing evidence

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available to you. I realize that you may have had only the very best intentions, and may have merely heeded very faulty counsel concerning DDT. If your position was taken in the sincere belief that DDT actually is producing detrimental effects upon the environment and that it actually might pose some dangers to man, then perhaps you will still consider modifying your stand after you have studied the evidence that so thoroughly refutes those beliefs. Surely the members of the Society will be equally willing to modify their beliefs when they have been exposed to unbiased scientific data resulting from the hundreds of pertinent experiments and observations and the testimony of the actual authorities on the subject.

If you are really interested in learning the facts concerning DDT and in permitting your members to be exposed to statements and data in opposition to those you have already so fully espoused, I would be delighted to provide information concerning any aspect of this controversy in which you are interested. I can assure you also of the whole-hearted support of more than three dozen highly qualified specialists in the pertinent areas of toxicology, nutrition, medical physics, gas chromatography, mass spectography, entomology, agriculture, public health, medical entomology, and many other aspects that are of great importance in the analysis of DDT and its effects on the environment and the creatures that inhabit this environment. I shall await your answer with great anticipation and fervent hope.

Sincerely yours,

J. Gordon Edwards

J. Gordon Edwards, PhD
Professor of Entomology
San Jose State College
San Jose, California 95114

cc Editor, Audubon Magazine
Sierra Club President, SanFrancisco

DDT—the WRONG insecticide

WHAT'S WRONG WITH DDT?

True

it remains toxic in the environment for at least 10 years and spreads by wind and water around the globe

it is harmful to wildlife, killing some animals outright and inhibiting reproduction in others *Not at environmental levels!*

it affects our food supply; our fisheries are particularly vulnerable *Read the facts!*

while the amount of DDT ~~now in our bodies~~ is small and has not yet proved *True* harmful scientists fear possible long range effects *who? NOT toxicologists, cancer specialists, or nutritionists!* *not informed scientists, certainly!*

WHAT ARE THE ALTERNATIVES?

That do not leave good [illegible] [illegible]

numerous other insecticides that do the job and become harmless to the environment within a few weeks *Great kill of non-targets with each application. Bees killed.*

[illegible]

non-chemical measures such as water level control to eliminate breeding areas, local destruction of diseased trees, *in forests?* introduction of natural insect eaters *Very little value, on most commercial crops*

THEN WHY IS DDT STILL USED?

it's inexpensive—large volume production, a result of its World War II fame, keeps its cost low *Not true at all... Volume is still low, and it's a small business in U.S.*

!! conclusive proof of its danger is recent—only now, after 10 *25, you mean?* years of research have scientists amassed irrefutable evidence *of what?* *(How much study went into this sheet??)*

WHAT CAN YOU DO?

use only such sprays as pyrethrum, rotenone, nicotine sulfate, methoxychlor, Sevin, malathion, diazinon, dibrom, guthion, Dursban, naled or Abate, and these with extreme caution—check the ingredients on the label

Great stuff! 300 to 500 times as toxic as DDT!

Often eliminates bees, thus prevents pollination. Is that your goal, too?

never use DDT, aldrin, dieldrin, endrin, or heptachlor; only qualified professionals should use chlordane, BHC, endosulfan or toxaphene for special limited uses

urge your neighbors, local tree sprayers and government officials to be guided by the above lists

make a tax-deductible gift to the National Audubon Society's Rachel Carson Memorial Fund, founded to finance our work in this area

antiinsecticidist? extremist lobbyist? [illegible] (Back to the dark ages with modern man?)

BAN DDT

The world is at last awakening to the alarm Rachel Carson sounded seven years ago. Sweden and Denmark have outlawed DDT. Here, Arizona and Michigan and a number of towns, mosquito control commissions and other governmental agencies have banned it; many more have restricted its use and still more are considering doing so. Public opinion against DDT is rising. *(But not among those who know anything about it)*

The National Audubon Society, a leader in this fight from the start, has launched an all-out campaign to finish the job. Our story is simply this: DDT is harming the environment we live in. There are other far less dangerous ways of controlling insects. Therefore DDT should be banned throughout the land, and banned from export. *You are exhorting to massive genocide!!*

We welcome your support in this campaign. *(Do you also welcome statements of fact that oppose your bias? I hope you have some fairness left!)*

National Audubon Society
1130 Fifth Avenue
New York, N.Y. 10028

I am grieved and sickened...

I can only hope you have been governed by poor advice and lack of personal knowledge, rather than deliberately proposing all these serious lies to public!

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SAN JOSE STATE COLLEGE

SCHOOL OF NATURAL SCIENCES AND MATHEMATICS
Department of Biological Sciences

23 November 1969

Editor
Audubon Magazine
1130 Fifth Avenue
New York, New York

Dear Sir:

I am enclosing a copy of a letter expressing my great personal concern to the Audubon Society offices. I think you should be kept informed of developments in the so-called "DDT-controversy" and I shall also take this opportunity to offer suggestions which might be instrumental in preventing the ultimate destruction of the Society. So far as I am concerned, Audubon Magazine has always remained fairly objective and reasonable when discussing DDT, despite the fact that many of your contributors are deeply involved emotionally. I have disagreed with many of the statements concerning DDT in the pages of Audubon Magazine, however I felt they were offered in good faith and I accepted them in that spirit. It appears extremely important that open lines of communication be maintained, and that each of the factions continue to be apprised of the scientific data bearing on the controversy. I have been willing to listen to all the charges against DDT raised by scientists, for if there really are dangers to the environment or its inhabitants (including man) I certainly want to be aware of them! Since the 1930's I have considered myself an avid conservationist, and I continue to do so. It is only in the DDT controversy that I have found it necessary to strongly oppose statements made by other conservationists, and I am truly saddened by this necessity. It is my firm belief that well-meaning conservationists have been skillfully and deliberately misled by a small group of extreme radicals with personal vendettas against society and with well-financed organizations to subsidize them. The culmination of years of propaganda by those persons and their untrained disciples has evidently been the criminally irresponsible leaflet now being distributed by the Audubon Society. It is that leaflet which has finally driven me to openly criticise the Society. I feel that I must fight the Society's new policy of advocating procedures guaranteed to result in world-wide genocide!

I realize that even the pressure of thousands of scientific facts will probably not alter the stance taken by the Society leaders, for they have already committed themselves so fully that they would face ridicule if they suddenly reversed themselves after learning the facts about DDT. Apparently no amount of proof is likely to exert enough influence to cause retractions of irresponsible statements publicized by the Society. Because I dare to hope that those of you in the editorial arm of the Society may not be firmly yoked with the other offices of the Society I am placing

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Defendant N.Y. Times SSS

my hope in the possibility that you may yet be susceptible to the pressure of facts. I am not in any way threatening you or the other officers, for I'm sure that threats from me would be ridiculous. Rather, I am pleading with you for a review of the scientific data before you place the Magazine so firmly against DDT and modern insecticidal controls that the future of the Society and the Magazine will be jeopardized because of adverse public opinions. Perhaps you do not fully realize how untenable the position expressed by the Society really is, or what a dedicated, highly-respected group of revered scientists is in disagreement with that position. I wish I had written this letter (and the attached one) a year or two ago, while you were still relatively uncommitted on the DDT controversy, but at that time none of the serious, competent scientists that I had ever met took the charges made by Wallace, Rachel Carson, Wurster, and the like, at all seriously.... all of us just assumed that their unfounded statements would be looked at, immediately discovered to be untrue or misleading, and rejected. It was not until early this year that I had any idea that sincere persons were actually taking those statements seriously! Unfortunately, we have allowed the opposition to gain much support from non-scientists and legislators who know nothing about biology, toxicology, or ecology, and they used that support to infiltrate the news media to a remarkable extent . Using the news media as a powerful ally, those same persons have then been able to threaten politicians by stirring up "grass-roots" movements among still more non-scientists (and still more scientists without the time or inclination to investigate any of the charges made against DDT.) In a very real sense, therefore, the opposition to the anti-DDT campaign has been caught completely off guard and will have to fight for years to compensate for their reluctance to engage in the fight.

The greatest ally that we have is truth. Eventually the public will hear of the details concerning each of the erroneous claims and frightening lies that have been perpetuated by the Audubon Society, but in the meantime we will see massive starvation and world-wide genocide beyond our comprehension. The news media will cease to publicize fake "cancer" headlines and will finally listen to the leading cancer authorities throughout the United States (and as a result they will publish the actual data concerning the "cancer experiments" that have recently been completed). They will begin to give notice to statements by the Chief Toxicologist of the U. S. Public Health Service, the Chief of Toxicology for the Food & Drug Administration, the State Toxicologists for Washington, California, and dozens of other states, and the professors of toxicology, medical physics, and nutrition in the greatest universities in this country. When they do publish the statements of those truly qualified scientists (instead of Asst. Prof. of Chemistry Wurster, Plant Taxonomist Peter Raven, and Entomologist Paul Ehrlich), the public will at last be able to read and understand the facts. How will that sudden realization of what is true affect the Audubon Society, which is now associated with what is demonstrably false? Obviously the Society will be placed in a most uncomfortable position.

What is the answer? I humbly offer the following suggestions, with the positive knowledge that the Society and the Magazine would definitely benefit by any slight trend in the suggested direction.
First, I believe the Society should maintain an open, academic, scientific attitude toward every controversy (in every controversy in the past I felt that we did). This attitude would be one of concern over any threat to the environment, investigation of those threats BY QUALIFIED SCIENTISTS instead of Wurster and his cronies, and the completely fair discussion of the

controversy in Audubon Magazine (if it is of real interest and concern to Society members, as DDT certainly is).

Next, I believe the Society should guard against any hint of anti-social or anti-humanitarian crusades. Until the Society advocated banning the export of DDT to foreign countries there could have been serious charges of complicity in the campaign to increase deaths from starvation, but we were not involved in any overt genocidal campaign. Humanitarians in this country and starving millions abroad might have been disheartened to see this great agricultural nation cutting down on our food production when they need it so desperately, but they could hardly have openly blamed their starvation on an intentional campaign on our part. Now that we are advocating a ban on shipping the life-giving chemical (DDT) to those countries facing hundreds of millions of deaths from insect-borne diseases, there can only be one interpretation of our action... we are deliberately advocating and attempting to enforce genocide! If we attempt to explain our proposed ban by such feeble arguments as "DDT in the fat tissues of falcons" we can expect wrath and indignation from many of the millions of persons whose very life we are sacrificing needlessly. If DDT really did have any serious effects on the environment, or really did persist in the soil, water, air, or living organisms, or really did cause cancer or tumors, or really did inhibit photosynthesis in marine algae, or really did inhibit egg production or development of chicks or older birds.... if any of these (or a combination of them) really were true, then at least we could use those as rational excuses for our action. The truth is, of course, that NONE of those items is really true at all, under actual environmental conditions, which removes all vestiges of believable reasons for our advocacy of world-wide genocide. Educated persons in this country and abroad are not yet generally aware of the Society's genocidal campaign, but I assure you that when they do become aware of it you will have to weather the righteous wrath of hundreds of thousands of them.... and that should not be a prospect that leaves you complacent!

I should say that you and your staff would be rather eager to begin to equalize the one-sided coverage of this DDT campaign, unless you intend to simulate Russian Lysenkoism. If you are willing to have your pages open to FACTS about the effects of DDT, please let me know. I can provide you immediately with the names of three dozen outstanding specialists in the various scientific fields that are important in the DDT controversy, and I assure you that any or all of them would be delighted to have the opportunity to present truthful analyses of the experimental data, the actual facts, and the professional point of view concerning any phase of the DDT fight. These outstanding scientists have now banded together in a "truth squad", and are personally financing the professional opposition to Wurster and his "Environmental Defense Fund". They are concerned by the extent to which lies and deliberate misstatements have misled the public and the legislators, and they regret the low level of credibility now evident in the biological sciences. Never before have we seen persons masquerading as "biologists" or "ecologists" widely believed and applauded for statements that are absolutely untrue. Scientific method, objectivity, truthfulness, reliability, pride in the profession, and human compassion.. .. all have vanished under the heel of these ruthless opportunists. Are we to remain powerless to rescue humanity from their sinister design? You, we hope, might help keep the potential catastrophe from enveloping us all!

Sincerely yours,

J Gordon Edwards

J. Gordon Edwards, PhD
Professor of Entomology

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SAN JOSE STATE COLLEGE

SCHOOL OF NATURAL SCIENCES AND MATHEMATICS
Department of Biological Sciences

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5 December 1969

Les D. Line, Editor
Audubon Magazine
1130 Fifth Avenue
New York, New York 10028

Dear Mr. Line:

I am very grateful to you for responding to my letters of the past two weeks concerning the position of the Audubon Society on DDT. Believe me, I can appreciate your position, and I fully understand that you must avoid taking actions that would not concur with the officers of the Society. The reason for sending you the copy of each letter mailed to the Society offices was that I was not sure of the relationship between the Society and the Magazine and I did want to be sure that you were completely aware of the genocide campaign and aware that the Society deliberately publishes lies about DDT causing cancer, killing birds, causing thin-shelled eggs, and persisting in the environment for years.

As a life-long conservationist, I have always held the Audubon Society in high esteem. It is deeply moving to observe the depths to which that Society has plunged in its inhumane and dictatorial stand. When the public learns the truth about this matter (and as you know, you cannot keep them uninformed forever) the rational members will be bitterly disappointed. Of course, we in this country are not really prepared to accept the fact that certain publications deliberately shield their readers from statements that have been proven to be positively true just so those readers can be encouraged to believe the lies perpetuated by persons with a controlling authority over those publications. Even after seeing this happen to the Audubon Society I still find it difficult to believe! I might add that I personally feel very sorry for you and your staff, for I am sure no editor could find it easy to cover up the truth (and I'm sure that a good editor, as you obviously are, cannot be unaware of the truth concerning the present Audubon genocide campaign).

I am having 500 copies of the letters to Audubon Society multilithed, and will mail them to the newspapers in every city in the United States. If one in every twenty finds the charges and the accompanying proof to be worthy of further investigation perhaps there will be enough advantage for suffering humanity to justify the cost of my efforts. Most Americans still seem to me to be capable of detecting the truth when it is made

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evident enough, and most of them still have enough humanitarianism left to enable them to feel sympathy for the millions of victims who will die of insect-borne diseases if the Audubon Society is successful in banning the export of DDT to those countries whose only hope of health and welfare right now is DDT.

Thank you again for your personal kindness in responding to my letter. The Audubon Society made no response whatever.

Sincerely yours,

J Gordon Edwards

J. Gordon Edwards, Chairman
Entomology Area
San Jose State College

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SAN JOSE STATE COLLEGE

SCHOOL OF NATURAL SCIENCES AND MATHEMATICS
Department of Biological Sciences

17 February 1970

Mr. Les Line, Editor
Audubon Magazine
1130 Fifth Avenue
New York, N. Y. 10028

Dear Mr. Line:

School has begun again, and I have just read the letter you mailed to San Jose State student Sharon Peponis in response to her sincere questioning of your editorial bias. I must say I was surprised and disappointed. I really thought you were an unwilling pawn of the directors of the Society, from the tone of your noncommittal letter to me in response to my own plea for journalistic responsibility on the part of the Audubon Magazine.

You closed your letter with a statement about the bird that Roger Tory Peterson recently referred to as the most abundant bird in North America . . . the robin. We find it difficult to feel more concern for your robin in its "death throes" (which have never been proven to result from DDT) than for two billion humans in the throes of malaria (which definitely IS preventable as a result of DDT). Evidently we just have a different set of moral standards and comparative values!

3. I still find it incredible that the Audubon Society leaders persist in their heavily-financed de facto murder plot against the human race, and I shall continue to speak out against their genocidal campaign to "ban all exports of DDT."

You attempted to create the impression that large amounts have been spent defending DDT. Surely you realize that this is not true, and that no real organized defense of DDT will be made by the chemical industry. After all, less than $3,500,000.00 worth of DDT is sold annually in the United States, and the pesticide industry will make more than ten times as much on the substitutes for DDT as it has ever made on DDT itself . . . no wonder they have not fought to save DDT! On the other hand, is it possible that you believe our students are unaware of the size of your anti-DDT budget, of the role of the Ford Foundation in your operations, and of the connection between Audubon Society and Environmental Defense Fund (with its $60,000.00 per year attorney)? Perhaps I may borrow a word you attempted to apply to our sincere, well-informed student? The word is "naive."

I was intending to write to you again to ask if the recent revelation by the British Advisory Committee on Pesticides had any effect on your Society's premature evaluation of the effects of DDT on bird-life. I shall enclose a copy of NATURE for Dec. 27, 1969, just in case you really

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are uninformed about the effects of DDT on birds. Please notice that the decline of peregrine falcons was NOT due to DDT at all, but was caused by dieldrin. (If you want to campaign against dieldrin, I'LL JOIN YOU.) Also please notice that the decline ended in 1966, yet the gullible people in our land were still being told that the peregrine was declining, right up to the day the British report was released, although the anti-DDT leaders were as aware as we were that such a charge was completely untrue. They used it for purely propaganda purposes, thinking (as did Hitler) that "the ends justify the means". Also please notice that the report was completed in November 1968, but that "it has taken a year for the report to see the light of day." (line 29). Do you wonder, as I have for many months, why the report was not issued sooner, especially in view of the widespread use of the alleged "effect" of DDT on the peregrines there. Do you wonder why the anti-DDT campaign in this country was so frantic during the interim between the completion of that report and its issuance? Did it seem to you that the anti-DDT team acted as if every day was vitally urgent.... as if they knew they would be hamstrung as soon as the report was made public? Do you wonder why they deliberately avoid mention of Jeffereys' work on British experiments with finches fed DDT diets for two years (resulting in thicker egg-shells)? Do you wonder why the mercury in the Michigan robins was not publicized? Do you wonder about the heavy concentration of lead in the California brown pelicans, coinciding with the egg difficulties that immediately followed the great oil leaks here last January? Do you seriously think that there is no rational reason for me (and all leading toxicologists) to view the entire anti-DDT campaign with repugnance and to perform the public service of attempting to point out the TRUTH about the charges, the experimental data, the field data, the gross analytical bungling by gas chromatographers, the sinister misstatements about the persistence of DDT and its "nondegradability"? And perhaps most important of all, can you blame people of good will for resisting a campaign designed to kill off millions of people in underdeveloped lands by with-holding DDT from the United Nations organizations, the World Health Organization, the Food and Agricultural Organization, the A.I.D., and the U. S. P. H. S.? Perhaps you can still retreat behind your simple-minded statement that "The articles in Audubon are deliberately and unabashedly biased in favor of a clean environment for man and his fellow creatures." I assure you that each rotting human corpse in those underdeveloped countries also contributes to a non-clean environment, and I find it difficult to imagine that your conscience can remain clear with millions of murders of humans in the tropics hanging over it. I simply cannot say "good luck" in your "deliberately and unabashedly biased" manipulation of public sentiment". From a moral viewpoint, your publication will be exposed as corrupt, and the more deaths you cause the stronger will be your castigation. You speak of a victory of David over Goliath, but I assure you there are many more appropriate biblical interpretations of your activities. (But it is still not too late to repent.)

Sincerely,

J. Gordon Edwards

J. Gordon Edwards
Professor of Entomology

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